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The
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SPECIAL CONFERENCE NUMBER

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Editorial

WE are publishing the Madras Agricultural Journal this month as a Special Conference number, including the papers that were presented for the Symposium on Maximisation of Food Production on the occasion of the Thirty-third College Day and Conference in July 1950. A word of apology is needed, to our readers and subscribers for the time-lag of over six months between the presentation of these papers and their publication, but this was to a large extent unavoidable. It is however a matter for gratification that it was after all possible, with the aid of a special Government grant, to publish the papers in a single issue. And in view of the persistence of the food shortage all over the country, the need for maximisation of food production and the desirability of the various

methods by which this could be achieved are in no way less urgent today than it was at the time the papers were presented in July 1950, as part of the Conference Symposium.

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ANNOUNCEMENT

The Thirty-fourth College Day and Conference will be held during the 2nd week of August 1951. Members are requested to send the amendments to rules, if any, sufficiently in advance for consideration at the General Body Meeting that will be held at that time.

T. S. LAKSHMANAN,
Secretary.

How Cultivation Increases Crop Production

By

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The maximisation of crop production is an all-important problem throughout the world. The prosperity and well-being of people depends on how we solve this problem. The production from land is conditioned by the operation of a number of limiting factors. As those limiting factors are overcome one after the other production goes up gradually. Agricultural scientists met in New Delhi from 6th to 9th April 1949 and tried to assess the depression caused by various limiting factors. It was then held that production could be increased (1) by 0·6% by reclaiming new lands for cultivation, (2) by 10% by using improved strains of seeds all over, (3) by about 20% when the major river valley projects reach completion, (4) by about 10% by controlling pests and diseases in the field and by another 10% by controlling pests of stored produce and (5) by 30% by resorting to timely and adequate cultivation of land and crops. That there are possibilities of increasing production is indeed heartening. The existing overall shortage of food is only 10% and given the will this shortage could be made up by a proper approach. It should also serve as a signpost for the cultivators. Increases in production at various levels have been shown to be possible in different directions. The most outstanding and substantial increase can be brought about by appropriate cultivation at the proper time and this also happens to be the easiest to adopt by the cultivators without assistance from others.

Cultivation is an all-embracing term and includes every operation done in the field for producing crops. Cultivation is done in this country mainly with human and cattle labour, and for want of labour or want of ready or circulating capital, the various cultivation operations done by the cultivators are often not done at the proper time, or are delayed. This causes a great depression in yields. The cultivators know when the operations should be done, but none-the-less are prone to be tardy for reasons sometimes beyond their control.

The cultivation of the soil has various objects. The preliminary cultivation of the soil aims at the removal of weeds before they mature and shed their seed and at the production of a surface soil condition suitable for the reception of seed and a favourable habitat for the tender seedlings. The final condition of the soil aimed at depends upon the fineness of the seed and the vigour of the germinating seedlings. Cotton, pulses. and the big-sized grains have a sufficiency of reserve food materials and the seedlings that emerge

are strong and robust from the beginning and it would be enough if the soil is brought to a coarsely powdery state. Tobacco, small grains etc., produce delicate seedlings and unless the seedbed is brought to a fine powdery condition their germination is affectd and they start growth with a handicap, which is never got over by any after-care. The preliminary cultivation should aim at a proper condition of the seed bed being produced with the minimum use of capital and labour. If ploughing and other cultivation operations are done when the soil has an optimum moisture content the effort required is the least, as also the number of times the operation has to be repeated in the field. The best and the most opportune time for the stubble ploughing is after the soil is moistened enough by the first rains after the harvest of the previous crop. It may be mentioned while passing that many wet lands that are ploughed in a wet state after the receipt of water in the irrigation system at present, may profitably be prepared in the dry state itself during summer and finished in a wet state on receipt of water. This would save considerable labour and facilitate the planting of paddy early in the season, which is conducive to high yields in the end. Large stretches of lands in Tanjore that were being prepared by wet-ploughing previously, have during the past two years been dry-ploughed with tractors with advantage. This may not, however, be adaptable to all soils and all places. In stiff clayey soils as in the Circars dry ploughing may depress the yield. The Samalkota experience is that earliar the dry ploughing is done the greater is the depression in yield. If the dry ploughing is however done within a few days before planting. there is a saving of labour and the yield is not adversely affected.

If the land is prepared in time and kept ready, sowing could be done immediately on receipt of rains. Otherwise time is wasted in preparing the land after receipt of rains and sowing is delayed thereby. This has a significant bearing on yileds. Most of the crops in general come to harvest during the cold weather, irrespective of the time of sowing and the early-sown crops give heavy yields and the late-sown crops give comparatively poor yields. The depression in yields caused by late sowings is quite considerable at times. Periamanjal cholam sown in September may yield about 50% less than the same crop sown by the middle of July under Coimbatore conditions. Almost every crop has its appropriate and optimum time of sowing which conduces to maximum yields. Timely preparation of land and sowing help in the aggregate to increase the overall production.

For the same reasons, paddy, ragi, and other crop nurseries should be raised early in the season, and the crops should be planted at the appropriate time. Finally, sowing and transplantation of crops influence the yield of crops more significantly than any other single cultivation operation.

Paddy crop is either sown straightaway in the field by broadcasting or is transplanted. Transplanting generally helps to increase the yields, and is more commonly resorted to in this State, where supply in the irrigation system is assured at a particular period each year. Where paddy is raised under rainfed tanks, the time of receipt of water varies from year to year depending on the onset of monsoon, and where this is uncertain, the cultivators resort to broadcasting, as being more convenient. Though this consideration could not be completely set aside, it may be suggested that wherever possible transplantation should be preferred to broadcasting as a method of increasing the yields.

Weeding is an important cultivation operation in agricultural practice. Weeds are hardy plants when compared to crops and the weeds have the upper hand in this unequal competition. Weeds have therefore to be removed as early as practicable to give the crop plants the necessary start in growth. Early weeding is therefore emphasised as one of the important factors that help to increase production. Sowing crops in rows with the help of drills facilitates the use of bullock-drawn implements for intercultivation, and is useful in areas where labour is not available in sufficiency. This is well evidenced in the Ceded Districts where sowing crops in lines and the use of bullock hoes for intercultivation are common features. With low and uncertain rainfall, the people of the Ceded Districts know too well that they could not afford to let the weeds grow their own way. They are aware that early weeding conduces to better crop growth and yields and are eager to remove the weeds early and give the crops the necessary start in life. Timely weeding helps to increase the yields of crops.

Placement of fertilisers: Considerable work has been done in other countries on the method of applying fertilizers. The best out of the fertilizers is had when they are placed close to the seeds in the field and the recommendation is to place the fertilisers in bands or strips 1 to 2″ on the sides of the seed rows and 2″–4″ below the level at which the seeds are placed in the drilled rows. Phosphates assist greatly in root development and its absorption by plants is greatest in the early stages of growth. It is best applied to the land before seeding or at sowing time. The placement of phosphates in bands near the root zone of plants does not dissipate the phosphates by fixation in the soil to the same extent as when it is broadcasted.

The application of ammonium sulphate to rice to supply upto 40 lb. of Nitrogen per acre under South Indian conditions is known to increase the yields appreciably. Three-fourths the quantity may be applied at planting time or within a month of planting and the rest a month before heading for best results.

Irrigation greatly influences the yield. The optimum quantity of moisture that conduces to the most economic yields should be applied to the soil. Rainfall is erratic here and confined to short periodic phases not spread over the entire growing period of the crop. Water lifted from underground sources entails great cost and difficulty and hence an economical use of irrigation water is emphasised.

Finally, there are regions of deficit rainfall like the Ceded Districts and the Central Districts. The proper conservation of rain water and soil assists in giving an assured yield normally, while haphazard cultivation and cropping methods often lead to failure of crops. This is a common feature in the Ceded Districts. The total rainfall is generally low and the rains are confined to certain periods. The dry-farming methods developed at Hagari and other dry farming research stations show conclusively that by proper conservation methods, crop production could be stabilised and the effect of the vagaries of the rains nullified to a certain extent by contour bunding. Bunds put up along the contours hold the rainwater that would otherwise flow over the land and be lost, carrying away from the surface fine silty and fertile fractions of the soil by erosion. The held-up rain water soaks into the soil for use of crops later, leading to a sort of stabilisation of the resources and insures crop production.

A brief review of the possibilities of increasing production by cultivation methods has been given. Agricultural scientists estimate that the production of land could be increased by nearly 30% by the adoption of proper and appropriate cultivation methods. These depend to a large extent on the personal skill and diligence of the cultivator and the resources at his command. Skill and diligence are personal factors and it behoves every cultivator to make the most of his resources, limited or otherwise, to increase crop production, by proper adjustment of the cultivation methods to his skill, resources and the requirements of the soil and the crop.

Maximisation of Crop Growth through Manuring

By

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The necessity of manures for crop growth has been recognised on all hands from time immemorial and is second only to water. Every farmer in any part of the world knows this; and it is unnecessary to labour this point before an assembly of expert agriculturists.

There is, however, one point which needs amplification here. In India it is common for the farmer to grow crops without manurial additions. This gives an impression that crops can grow without food. This seeming confusion of thought is brought about by the forgetfulness that plant foods are already present in the soil and when crop is grown without visible addition of manures to the soil, it means that they obtain their manurial requirements from the soil itself. This practice has been going on for several centuries in India, raising a crop without manuring, and it is a matter of wonder, and for deep thankfulness to nature, that a fairly decent crop is still obtained. The soils in India are presumably not easily emptied of their plant food due to some factor. Perhaps India is under the special care of the Gods, who in their bias towards us, rejuvenate our soils periodically.

We have been complacent for centuries about the crop yields obtained from our lands. At the present moment however, we have received a tremendous shock which has jolted us out of our self-satisfaction with our crop yields. We are facing a crisis and are, it is hoped not belatedly, trying to improve our crop yields.

The pessimist thinks that this is a superhuman task. He talks of the closed mind of the ryot to modern thought and his stubbornness to follow in the footsteps of his fore-fathers. The frequent visitation of "Acts of Gods" such as drought, floods, cyclones, pests and diseases individually and collectively, bring down crop production. It would perhaps be more correct to say "Acts of the Devil" for these visitations, rather than ascribe them to acts of God. But there is a silver lining to these dark clouds in that such visitations are never throughout the country and there would be vast stretches where a normal season obtains and a normal crop. To offset these calamities the normal crop in these areas should be bettered and this again improved and the maximum of crop production obtained.

In the past four decades of experimentation in the various Agricultural Research Stations of the Madras State with all the major crops and with many fertilisers and manures, it is now possible to sum up our information and to state without fear of contradiction, that other factors being favourable, it is certainly possible to maximise crop production through manuring. The increases in yield obtained under favourable conditions in many Research Stations are indeed spectacular. To cite only a few instances: in the case of paddy, a Thaladi crop gave 111% increase, by the application of 5,000 lb. of green manure; Co. 13 gave 128% increase in Tirurkuppam, due to green leaf at 10,000 lb. per acre. In the Central Farm 107 and 97% increases due to green manure have been obtained in A and D blocks. In the case of sugarcane an increase of 180% has been obtained in Gudiyattam and a 62% increase in Palur, due to nitrogenous manures. In the case of cholam 68% increase in Koilpatti due to farmyard manure, 77% in Nandyal due to nitrogenous manure and 300% increase in Siruguppa due to nitrogenous and phosphoric acid manures have been obtained. By the application of nitrogenous manures to cotton, 63% increase in Palur, 81% in Koilpatti, 175% in Siruguppa and 47% in Nandyal have been obtained. In potato 97·4% increase in yields have been obtained at the Nanjanad farm by the application of complete fertilisers consisting N, P and K.

As mentioned before, only the most spectacular reactions to manuring have been culled out and presented to indicate the potentialities of manuring. From the list given above it will be seen that such spectacular responses have been obtained from one corner of the State to the other. It is not localised to any particular research station nor to any one crop.

The percentage increase of yields due to manuring does not give a clear picture of the potentialities of our soils. Any text-book on agriculture or any article dealing with the subject states that the average yields of this country is very near the bottom, if not the last, of the world figures. It is generally accepted that the average yield of paddy in India is only 1,000 lb. per acre and slightly higher about 1,500 lb. in Madras State. Accepting these figures as more or less correct, perhaps slightly on the optimistic side, the average yields obtained in the past few years in our Agricultural Research Stations will give a clear picture of the potentialities of our soils. At the same time it should be kept in mind that we have not, by any means, reached our maximum production as yet. The average yield of paddy in Samalkota is about 4,000 lb., Central Farm and Paddy Breeding Station, 3,500 lb., Aduthurai 3 000 lb., Anakapalle, Maruteru, Pattukottai and Tirurkuppam 2,500 lb. and Pattambi, 2,000 lb. Similarly it is held that the average yield of sugarcane in India would be about 15 tons per acre. The average yield in Anakapalle and

Palur and Gudiyattam would be about 40 tons. Again the average yield of potato in the Nilgiris is around 8,000 lb. whereas at Nanjanad, yields of 15,000 lb. are now being obtained for several years.

It is a matter for legitimate pride that in a short period of three decades, we have been able to increase considerably the average yields in our Agricultural Research Stations of many of our crops. This has been achieved by the co-ordination of all the correct agricultural practices, not the least of which is manuring. At the same time it should be admitted that this laudable achievement has stopped within the wire fencings of the Research Stations all these years. Recently, however, due to various causes, chiefly due to the high prices that prevail for agricultural produce, the ryot is becoming manure-minded, and is clamouring for manures. Take the case of sugarcane; the ryot is prepared to buy manure even at black market prices. It is now a rarity to see sugarcane cultivated without application of heavy doses of manure. While the departmental recommendation is a maximum of 250 lb. of nitrogen per acre, in the Nellikuppam area it is not uncommon to find that the ryots are applying as much as 500 lb. of nitrogen per acre. Similarly in the Nilgiris, potato is always grown with manures by the ryot. In the case of paddy, however, this manure-mindedness has not assumed such a wide prevalence though even here, it is now common to see this habit is taking hold of the ryot. Kolinji plants are brought from a distance of about 30 miles to Bhavani, bundled as bales and sold to the paddy cultivator under the Kalingarayan Channel at 30 rupees per bale of about 1,000 lb. Similarly in Ambasamudram area also, green leaves gathered from the the forests fetch about 30 to 50 rupees per cartload. The fields near Madeswarankoil near the Agricultural College is a classic example where 100 cartloads of compost per acre is not an uncommon application for a crop of cotton. All these augur well for the country and in course of time is sure to raise the standard of crop production and the average yields of crops in our State.

There is not enough fertilisers and manures to meet the demands of the country. We import every year about a crore of rupees worth of fertilisers, chiefly ammonium sulphate and superphosphate. The fertiliser manufacturing plants in the country produce about 22,000 tons of ammonium sulphate. Our natural resources in the shape of cattle manure, composts, bonemeal, oil cakes etc., are small and meet only a fraction of the demand. There is considerable possibility of increasing production of compost and green manures. Even so, there will always be a considerable demand for quick-acting nitrogenous and phosphatic fertilisers. Importing these commodities every year from foreign countries is in no way different from importing foodgrains, from the point of depletion of our finances. The Government of India are aware of

it. It is expected that the Sindhri Factory would soon come into production and that production would be increased considerably at Alwaye. But this is possible only with nitrogenous fertilisers. We have still to depend on foreign countries for the supply of raw materials for superphosphate manufacture and to a certain extent for potash also, since these two do not occur as deposits in our country to any large extent.

For obtaining a decent yield of paddy, say, about 2.500 pounds per acre it is necessary to add to the soil something like 5,000 lb. of green manure plus 30 lb. of nitrogen plus 30 lb. of P_2O_5. This quantity of manure multiplied by 8.5 million acres under wet paddy in the Madras state, assume astronomic proportions. This quantity of manure can be reduced somewhat by adopting the T. V. A. plan of indirect fertiliser application to the green manure crops. The T. V. A. authorities claim that the large measure of success achieved by them in the rehabilitation of the wornout soils of the Tennessee Valley was mainly due to this plan. Briefly, this plan lies in growing a leguminous green manure with phosphate manure application. The phosphate manuring greatly stimulates the capacity of the legume to fix atmospheric nitrogen. Thus for the expense of one manure, phosphate, three manures, phosphate, nitrogen, and the much-needed organic matter are secured at one stroke. This idea is under experimentation in many of the Agricultural Research Stations for paddy and at Nanjanad orf potatoes.

The plan of the experiment is to grow the commonest leguminous plants of the State, dhaincha, pillipesara, cowpea, sunnhemp and lupin in Nanjanad, with 30 and 60 lb. of P_2O_5. in the shape of superphosphate, plough in the green matter into the field, and then grow paddy (or potatoes in Nanjanad) with no further manuring. While it is too early to draw definite conclusions from these experiments the indications at present are very encouraging. If these experiments prove successful they would show a 50% reduction in our manurial bill, not only for paddy but for many other irrigated crops.

In recent years some cross cuts have been employed to overcome the high cost of manuring with some success. Presoaking seeds in nutrient solutions, vernalisation to shorten the growth period, use of hormones and other growth-promoting factors to shorten the resting period of the seeds have been tried and have given encouraging results in this laboratory.

Based on the results obtained from many years of experimentation at the Agricultural Research Stations it is now possible to recommend in a broad and general way, dosages of manures required for producing maximum economic yields of the major crops of the

Madras State. Naturally there will be variations due to soil climatic zones, and hence these basic formulæ will require to be modified to suit local variations.

Paddy: 5,000 lb. Green manure plus 30 lb. N., plus 30 lb. P_2O_5.

Note: Malabar and Wynaad soils require a larger dose of P_2O_5.

Sugarcane: 5 tons cattle manure plus 100 lb. N (in the form of groundnut cake and ammonium sulphate in 3:2 ratio) applied in two instalments at planting and earthing up time.

Higher doses up to 250 lb. nitrogen can be recommended for Nellikuppam area.

Cholam Ragi: (Dry or Irrigated) 5 tons cattle manure per acre. Irrigated cholam has given increased response with addition of 30 lb. of N as fertiliser.

Cotton: Nitrogen 50 lb. plus 25 lb. P_2O_5 plus cattle manure or compost 3 tons.

Cotton: (Rainfed) Nitrogen 50 lbs. plus 20 lb. P_2O_5 plus 20 lb. N. in the form of groundnut cake over 3 tons of cattle manure or compost. This should preferably be applied to a previous crop of cereal to benefit both.

Banana: 50 lb. N. plus 75 lb. potash plus 45 lb. P_2O_5 per acre.

Potato: 80 lb. N. plus 200 lb. P_2O_5 plus 100 lb. K_2O.

Minor Millets: Farmyard manure or compost to give 50 lb. of nitrogen.

While it is undoubted that manuring would increase crop production to a substantial extent in the very year of its application, the maximum effect is seen only by continued application year after year for a considerable period. A reserve of plant food is thus built up and at the same time when organic matter as basal applications are included in the manurial schedule, the physical texture of soil is rendered optimum for crop production This would require that the manure consciousness of the ryots of the State be stimulated to the extent as obtains in China where it is considered a sin to waste any organic substance. This is not an insurmountable task and the present awakening by the ryot can form the spark which could be fanned to a splendid flame.

The part played by improved seeds in the maximisation of crop production

By

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Many a sudden crisis in the agricultural industry and economy of a country have been successfully solved by the crop breeders. The achievements in the field of plant introduction and development of new tracts have considerably helped the maximisation of production in most countries. Some of the notable contributions are (a) the discovery of new beet varieties having a sugar content of eight percent over the older types when enemy blockade threatened to cut off sugar supplies to France during the Napoleonic wars, (b) the selection of blight-immune varieties of potato when the Irish peasants were faced with total loss of their staple crop, (c) the development of early-fruiting varieties of cotton which staved off the ravages of boll weevil in America, (d) the evolution of wilt resistant strains of cotton which made the cultivations of wilt sick S. E. American possible, (e) the breeding of new races of cotton and wheat suited to the extensive areas in U.S.S R. characterised by low mean temperature and short cropping seasons, (f) the conversion of Egypt, a minor cotton-growing country during the early part of the nineteenth century, into the main supply base for the world's requirements of long staple cotton, (g) the large expansion of cotton cultivation in South Africa, through release of jassid-resistant cotton varieties, (h) the successful exploitation of hybrid vigour in maize by America and (i) extension of sugarcane cultivation in India to regions originally considered unsuitable.

2. The march of genetics and the resultant refinements effected in breeding technique during the present century have been phenomenal. They have opened up immense opportunities for the creation of better and newer races of crops suited to the exacting conditions of climate, soil and man. The progressive countries who had the early advantage of such basic knowledge instituted an intensive research on crops as part of State concern by providing liberal funds for epuipment and material on a permanent basis. Recent crop surveys in America have indicated that advances achieved in the field of breeding have more than offset the declining fertility in continuously soils and have enabled the farmers to maintain average yields inspite of increasing damage by pests and diseases and to extend the cultivation of crops to areas of high risk and recurrent hazards of weather.

3. Plant breeding work in India is scarcely forty-five years old while that in Madras is much younger, most crop sections except rice having come into existence only after the year 1920. During

these thirty years, the crop breeders have to their credit several new varieties in all the major crops like rice, cotton, millets and oilseeds. Many of these improved varieties released for cultivation were the outcome of straight selection made in cultivators' bulk or in crosses effected between closely related varieties. They have solved to a very limited extent the problems of deseases, pests, duration, drought, lodging, quality and yield of finished produce. Most of the varieties judged from their respective area spread, must be deemed to possess only a limited adaptability. The full advantages of improved strains are very often not realised on account of the limitations in the quantities of pure seed produced for distribution by the Department leaving the bulk of the adaptive area to natural spread having a purity range of 60 to 95 percent. Such a state of affairs is beset with two drawbacks vix., (1) The increases in production will be more or less roughly proportional to the purity grade of the variety grown and (2) The fall in production will be in geometrical proportion to the impurity in the seed material used for successive plantings. An all-out effort made in covering the entire adaptive zones with pure seeds will therefore help in increasing the production per unit area proportionate to the impurity found in seeds used for sowing by cultivators.

4. The official estimates of area spread of improved varieties place rice at 48%, cotton at 50%, sugarcane at 95% and millets and oilseeds at 10% of the respective annual areas. Notwithstanding the large spread of rice and sugarcane, the normal outturns per acre figuring in the Season and Crop reports have remained more or less stationary. It should however be interpreted as an indirect tribute to the new varieties which have helped to maintain the normal yields inspite of extension of cultivation to new areas, the seasonal losses resulting from unkind weather and damage by pests and diseases. The normal yields of cotton which were 250 lb. for irrigated and 35 to 54 lb. for unirrigated areas in the districts of Coimbatore, Salem and Tiruchirapalli in the year 1921-1922, have been revised to the higher figures of 300 lb. for irrigated and 85 to 125 lb. for unirrigated cotton. In this connection, it will be worthwhile to review the trends seen in the crop-cutting experiments on rice in Madras conducted during 1948-1949. The estimates as per sampling method were (a) 39% of rice was under improved strains, which in turn gave 30% increased yield over the cultivators' bulk (b) the total production of the State was higher than the official figures adopted in the Season and Crop reports by 5% and (c) the productive capacity of the Departmental strains registered further increases upto 33% when associated with manures. There was one definite indication in these crop-cutting trials. Improved strains of rice were noticed to respond invariably well under conditions of high fertility. It would therefore appear that a great portion of our present deficit could be reduced by undertaking an intensive manurial campaign in areas where our strains have largely spread.

5. One of the greatest difficulties in the case of food crops, has been the need to breed and multiply a large number of varieties suited to varying environments of the State. Other countries especially America, have solved similar problems by developing newer varieties having wider range of adaptability and by creating one variety community blocks on a zonal basis. Emphasis on this objective must be laid in all our future programmes of work. Reduction in the number of improved strains will help the State in the maintenance of purity and the production of large quantities of pure seeds at low cost. This has been achieved in the case of sugarcane and Cambodia cotton. Uganda-1 is a new versatile cotton which does well over the whole of the Cambodia - irrigated and unirrigated, summer and winter-planted area.

6. The objective of all official policy is to stimulate production. Even in America, the benefits of science widely advertised among the farming communities through state leaflets and farm magazines and followed up by persistent and intensive propaganda, were regarded in the early part of this century as impractical and 'book farming' by a large section of the farmers. Times have changed since then. They are now voluntarity seeking advice to an ever-increasing degree and are over-enthusiastic in putting into immediate practice the latest discoveries. Our propaganda machinery being on a low organisation level may fail to provoke our farmers into active collaboration and may slow down progress unless other methods are adopted. State legislation has helped Egypt in increasing and maintaining the national yield and quality of cotton. Similar isolated acts are found in Bombay and Hyderabad in so far as they relate to cotton. The most recent example of such legislative enactment is 'The East Punjab, improved seeds and seedlings Act of 1949', whereby only specified varieties of crops can be grown in notified areas. It is time that the advisability of enacting similar acts in other States of India, is seriously considered as additional measures for stepping up production.

7. As a result of the second world war, intensive campaigns were and are still being made for increasing the production of food crops by granting water concessions and by bringing new areas under the plough. The area figures given in the Season and Crop reports for the three years namely 1938 — '39, 1944 — '45 and 1947 — '48 indicate that (1) irrigated crops of rice and sugarcane maintained a steady rise in area while cotton and millets changed little till 1944 — '45 but definitely declined later, (2) among the major unirrigated crops groundnuts replaced others to the extent of about six lakh acres by 1944—'45 and (3) the gross cropped area which rose up by nearly a million acres during 1944—'45, fell down to the 1938 — '39 level in the year 1947 — '48. Even admitting that a good portion of this decline may be due to inadequate monsoons, the failure to utilise the rest of the area

remains to be satisfactorily explained. Most of the area newly brought under the plough will be poor in fertility and generally unsuited for the cultivation of improved varieties. They probably proved unremunerative to the farmer who preferred to abandon such areas in subsequent years. The development of such new lands can therefore be best done by insisting that the cultivator must grow one or more crops recommended as suitable by the State. There is again a large extent of lands in the rice deltas which remain fallow during summer and which can be cropped intensively. The solution of waste areas and fallow lands require a bolder breeding approach. Varieties suited to deficient soil moisture, short cropping season and poor fertility have to be evolved. They require the application of the latest breeding methods like distant hybridisation involving rare genes found in wild ancestors, exploitation of polyploidy and utilisation of hybrid vigour. The progress in all such programmes will be slow and will need the whole time of specialised workers. A beginning has been made in using hybrid vigour for the improvement of cumbu. The first fruits of such distant hybridisation with wild cottons have been obtained at Coimbatore. These new types possess extreme resistance to drought and a total crop life of 135 days. They are expected to be useful in extending cotton cultivation to regions of deficient soil moisture and in the development of extensive rice fallows of Tanjore where duration is the limiting factor. We are just beginning where others have considerably advanced and with proper planning, the internal production of major commodities can be pitched upto the self-sufficiency level, making the State investment on the breeding programmes and genetic research pay many times over.

The Importance of Pest Control in the Maximisation of Crop Production

By

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It may not be easily understood how, of all agricultural improvements, the control of crop pests can contribute for the maximisation of production. Pests occurring on crops damage them and reduce the yields and when they are controlled we prevent the loss that would otherwise have occurred. Varietal, cultural and manurial improvements are directly associated with the maximisation of production, but operations carried out for control of pests connot add to the yielding capacity of plants, but can only check the damage to crops. How then can we secure maximisation of crop production through control of pests ? If it is conceded that there is a

regular loss from year to year in the production of our crops in the country as a whole through pests occurring somewhere or other and the yields obtained now are exclusive of those losses, any attempt made to prevent such losses can help in increasing the net out-turn and raise the yields. That is how, pest control has its due importance in the maximisation of crop production in the country.

2. Having accepted that control of crop pests is one of the items for maximisation of crop production, it remains to be seen to what extent we can increase the production. We do not have statistics to show the exact extent of damage done to crops by pests. This cannot be estimated easily as there are various pests damaging crops in different years and the extent of damage caused by them varies with the tract, crop, variety, season and agricultural conditions. It has been said that "it costs the American farmer more to feed his insect foes than it does to educate his children. The yearly loss from insect ravages to crops come to nearly twice as much as it costs to maintain their army and navy, more than twice the loss by fire, twice the capital invested in manufacturing agricultural implements and nearly three times the estimated value of the products of all the orchards and vineyards in United States of America". As far as our country is concerned it has been assessed by authorities that the annual recurring loss due to crop pests and losses in storage can be taken as 10 to 15 per cent. Therefore, there is scope for increasing our crop production to the extent of 15 per cent through effective control of pests in the fields as well as in the granaries.

3. To some it may appear whether we cannot become resigned to this loss and make it good in some other direction. It must, however, be said that the figures of the average losses are very often deceptive in that they do not allow us to understand correctly or appreciate the losses by individual agriculturists. We need not consequently be under the impression that the individual agriculturist is forced to forego his crops in the field only upto the extent of 10 per cent. In most cases the losses may be anything from 20 per cent to the entire crop. Since we know that most of the agriculturists in our country have a sort of hand-to-mouth existence, we can understand what it would mean if a petty cultivator has to forego most of his crop in a particular year. The loss is not only for that year for him, but his economic condition also gets further undermined and the effect of such a loss is felt by him over several years that follow. The *ber* fruit fly and the pomegranate borer pests have rendered the growing of these fruit trees unprofitable and the area under them have dwindled. Mangohoppers threatened a similar situation in Chittoor. Cabbages could not be grown successfully on a commercial basis in the Krishna district till an effective remedy was forthcoming for its pests. The earhead bugs of paddy and

cholam inflict severe loss on these crops in some parts of this State. It can be seen that there is every need to save the ryot from such uncertainties and losses.

4. Protection is the primary duty of any State, whether it be from external aggression, internal disorders, unsocial acts, or epidemics. Many of the advanced countries in the world have a well-organised machinery to afford protection to the agriculturists in the form of crop protection and animal husbandry sections. In our State, Plant Protecion is in its infancy and requires careful nursing to develop it to the extent obtaining in more advanced countries.

5. A beginning has been made in 1949, the first year of plant protection service, towards maximising production. Grasshoppers, cutworms, red hairy caterpillars, earhead bugs, jassids, and rodents are the worst pests of crops and if these are controlled, there will be a significant increase in crop production in general in South India. We have now effective remedies against grasshoppers, cut worms etc. and efforts are being made to popularise these methods of control among the ryots. We have yet to find an effective method for controlling the hairy caterpillar pest. There are other pests like jassids, tingids, thrips, plant lice, etc., which may not cause spectacular destruction of crops but heavily reduce the yields. We have fortunately now with us insecticides of high potency, fairly cheap and easily available, such as BHC, DDT and zinc phosphide and we can now be confident that we can control most of the pests. In the use of the latest drugs on a large scale, there may perhaps be a doubt whether we are right in using imported materials instead of relying on indigenous products. But there is considerable difficulty in the indigenous drugs competing with the synthetic products in collection, preparation and standardisation. Still, this line has been explored to some extent with pyrethrum, tobacco, Lobelia, Sweet flag, Thevetia, Tephrosia, Anona, Neem, Pedilanthus, Gynandropsis, etc. but till we bring these into large-scale use in plant protection, we have to rely on the synthetic insecticides that have already established their utility.

6. In maximising production we have also to concentrate on crops like paddy, sugarcane and cotton, which are in great demand at present though the other crops cannot be neglected. We have got fairly satisfactory remedies against pests that feed on the surface tissues of plants. It is only the borers that live and feed internally that are still evading control. All possible attempts are being made to follow their life histories and habits to get at their vulnerable points when some of the latest synthetic insecticides can be used effectively. This line of attack is not so easy to yield quick results but has to be pursued with patience till we get at some way of utilising these drugs.

7. It may now be asserted that we have a potent weapon in the latest insecticides and that we can certainly contribute towards maximisation of production through their use. The research staff that has to work on the fundamentals has to be strengthened for intensive work to secure the maximum benefit out of these wonder drugs. There are a number of new insecticides and their combinations, on the market such as Metaldehydes, Dichloro-propane, Ovicide, etc., and it is quite possible that some of these might prove even more effective than BHC or DDT. The plant protection staff is also to be further augmented.

8. *Storage:* Due to vagaries of seasons coupled with the changing economic conditions in the country, the production of food grains is not up to our requirements. To augment our stocks of food grains in the country, large consignments of food materials have had to be imported. It then devolved upon the Government not only to protect the growing crops in the field but also the stored food reserves. The imported grains had to be examined and fumigated for safe storage. Necessary precautions had to be taken to see that these are not reinfested until released for consumption. A separate organisation of entomologists under the control of the Board of Revenue was created to attend to the problems of food storage. These entomologists, have added not a little to the country's stock of food grains by preventing losses in the produce harvested and in their storage.

9. The expenditure incurred on the plant protection and storage service is very little when compared to the other protections the State is affording to its people. The State can and should encourage this service that is now proving its usefulness to the agriculturists and secure maximisation of production to make up the country's deficit in food crops.

The importance of disease control in Maximisation of Food Production

By

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All of us realise only too well that the needs of our nation for a good many years to come, are going to depend very much on the amount of food and other raw materials we can grow in our country. In many ways, in spite of all our efforts, the position is just as serious as it was in the immediate post-war years. This paper will indicate briefly the heavy toll taken by the various crop diseases and the methods adopted to check or control them, so that we may attain the maximum yields for the crops grown in this country.

Crop diseases cause in some years considerable losses to the farmers. Exact statistical data as maintained by other countres like the U. S. A. are not available in this country. Still there are some approximate estimates in regard to certain important diseases. The smut of sorghum was reported to be responsible for a loss of over one crore of rupees in the Bombay Province alone before control measures were undertaken. The loss from this disease in this State also used to be very high. The rusts of wheat reduce the yield to the tune of 10 crores of rupees. In our State the blast disease of rice is often severe in Nellore and Tanjore districts, reducing the yield by 50%. In other diseases like the *Mahali* of arecanuts and fruit-rot of oranges the entire yield may be wiped out in some years if proper precautions are not taken. These instances illustrate the enormous losses in food material and other products caused by plant diseases.

Most of the crop diseases are caused by parasitic organisms which infect particular crops in particular seasons. For the widespread occurrence of a particular disease the presence of the parasite in large numbers, the prevalence of suitable environmental conditions and the presence of the concerned host at the right stage of growth in large areas must synchronise. If it is possible to control one or other of these factors the intensity of the disease can be appreciably reduced. The plant pathologist is often faced with difficult problems. He gets information about the occurrence of a disease only after the parasite has established itself and has caused appreciable damage. At this stage he is expected to do something and cure the disease. It must be stated at the outset that this is well-nigh impossible. Unlike in human diseases in most of the plant diseases, only protective measures are practicable. Curative measures are not very effective. It must be remembered that once a plant has been invaded the progress of the parasite cannot be controlled by administration of medicines. The only course open is to remove and destroy the affected member so that the rest of the population may be saved. In this respect the plant doctor has an advantage over the human doctor.

Therefore protective measures have to be adopted in time to prevent the occurrence of diseases. These measures aim at the destruction of the parasite, improvement of the host or alteration of the environment. In a number of diseases affecting food crops, the parasite is present on the seed used for sowing and it is able to infect the plant in the seedling stage. Immediate destruction of the host may take place as in foot-rot of rice and seedling blight of various crops or the destructive action may be delayed as in the smuts. In both cases loss of the crop results. If it were possible to destroy the parasite which is present on the seed without affecting the seed, the disease can be prevented. Fortunately this is easily practicable and seed treatment with chemicals is an effective way of improving the stand and increasing the yield of crops like rice, sorghum, wheat,

tenai, peas, beans etc. Organo-mercury compounds like Ceresan and Agrosan and also sulphur have been found to be very effective in many instances. Besides destroying the parasites present on the seed the organo-mercury compounds protect the young seedlings from being infected by parasites prevalent in the soil. Over 30,000 acres of rice and 1,20,000 acres of sorghum have been sown to treated seeds during the year 1949-50 in this State.

Destruction of parasites present on the surface of the foliage, flowers or fruits like the powdery mildew of mango, grape, orange, bhendi, cucurbits etc. is easily brought about by dusting finely powdered sulphur on the affected parts. The earlier the treatment is carried out the better would the results be.

But in a large number of cases the parasites are internal and any fungicide applied after infection will have no effect on the parasite. In these cases preventive treatments have to be adopted. The diseases usually break out during or after the rains or when heavy dews are falling. From previous experience the normal period of incidence will be known. Before this period it is necessary to cover the surfaces of the vulnerable parts of the host plant with a fungicide so that the parasite when it falls on the host is immediately killed. Care has to be bestowed on the selection of the fungicide, as some may have toxic effects on the host. Others may become toxic if they are not carefully prepared. Bordeaux mixture which is prepared by mixing together solutions of copper sulphate and calcium hydroxide is a very good fungicide. It is used all over the world for protecting crops against diseases. In our State it is used for controlling diseases of potato, tomato, rice and ragi nurseries, oranges, grapes, coffee, areca and rubber. It is sprayed on the plants before infection. Unless it is prepared in the correct manner and applied in time the results may not be encouraging. Various proprietory preparations are now in the market for use as protective and preventive sprayings. Plant sanitation also helps in reducing the population of the parasite and thus checking the spread of the disease. These measures can be profitably adopted in the case of vegetables, orchard crops and bananas.

But these methods are not of much use against certain diseases affecting rice, wheat and other cereals and root diseases of orchard crops. Blast of rice, rusts of wheat, sorghum etc., virus diseases and root-rots of fruit trees are examples of such diseases. It is however well known that in these crops there exist certain varieties or species which do not get affected or which are able to grow normally in spite of the disease or in other words they are immune, resistant or tolerant to the diseases. Many of these varieties are not commercially important. Herein the pathologist and the breeder can cooperate and combine the resistant and desirable characters into one strain by breeding methods. Several instances of successful control of the disease by production of resistant varieties

are available. The rice cultures Co.25 and Co.26 are highly resistant to paddy blast and over 20,000 acres have been cultivated with these in Tanjore with great benefit and have given high yields while other varieties were affected. Similarly in tenai, a culture has been isolated at Hagari which is highly resistant to rust. A number of varieties of wheat are resistant to black rust. Sugarcane varieties resistant to mosaic are now under cultivation. In the vegetables examples of resistant varieties are found in peas, beans, turnips, tomatoes etc. This method of controlling diseases is by far the easiest. But there is one snag about it. Each crop is susceptible to several diseases. It is impossible to get one variety or strain which is resistant to all diseases. Wheat is infected by three kinds of rust. Great difficulty is experienced in producing one variety which is resistant to all the rusts. Furthermore, a resistant variety does not behave in the same manner always when grown in another locality. Besides, the parasites are living organisms and mutation and hybridisation occur in them also. These result in the development of more virulent races of the parasitic organisms themselves. The sudden appearance of severe epiphytotics in a variety after a number of years of resistant behaviour has to be attributed to these causes. It puts back the clock of breeding work and the whole problem has to be tackled again. Thus there is no peace to the pathologist or the breeder and breeding resistant varieties is an eternal struggle in which success cannot always be assured.

The effects of crop diseases can be minimised to some extent by proper manuring and irrigation. Over-irrigation or lack of water both affect the root system and reduce the vigour of plants. Blast disease of rice is more severe in fields lacking proper water supply. Root rot of oranges are common in orchards which are over-irrigated and under-manured. Excess of nitrogenous manures increase the susceptibility of several varieties of rice to blast disease. Thus proper attention to the cultural and manurial requirements helps to control certain diseases by improving the condition of the plants. Starvation weakens the plants and makes them liable to infection by various parasites. In this the grower has to see that the plants are well taken care of.

Changes in the environment often produce conditions either favourable or unfavourable to the onset of crop diseases. Soil, atmosphere and sunlight form the chief environmental factors influencing the incidence of diseases. If it were possible to modify or adjust these factors so that they are unfavourable to the occurrence of the disease the crops may escape or avoid the infection. By reducing soil acidity by addition of lime to the soil the club root disease of cabbage can be reduced. Soil temperature and moisture influence root rots and wilt diseases. By regulating the time of sowing and depth of sowing soil-borne infection is avoided in diseases affecting sorghum and oats. Under local conditions–September, planted ragi often suffers heavily from blast. By adjusting the time of sowing

this can be avoided. Late-sown crops of sorghum are usually affected by sugary disease. The only way of avoiding this disease is to sow early. Under rainfed conditions this is not always easy. Sunlight favours some diseases like coffee rust and provision of shade helps in reducing the intensity. Chillies fruit-rot is reported to be less under shaded conditions. But shade favours certain other diseases like mildews and black rot of coffee. Lessening the shade will be helpful in such cases.

Legislative measures are sometimes employed with the hope of checking certain crop diseases. These usually aim at preventing the spread of diseases by prohibiting the transport of diseased materials from one State to another or within the State itself the movement of the particular crop plant may be restricted. Or the diseased plants are compulsorily destroyed to reduce foci of infection. Quarantine regulations at ports are designed to prevent the entry of other diseases from outside. Sometimes cultivation of certain crops are banned either completely or in certain seasons. This legislation must be introduced only after all other methods of control have failed, and if it is fully supported by scientific evidence. At present the cultivation of summer wheat has been banned in this State in the hope of reducing wheat rust in peninsular India. This was based on the presumption that the Nilgiris and Pulneys form the centres of infection. Results of surveys of rust incidence on wheat have shown that black rust of wheat for the control of which this ban has been introduced, occurs much later on the hills than in the plains. This indicates that the hills are not the centres of infection. Moreover, though the ban has been in operation for four years, there is no evidence to show that the incidence of rust has been reduced in peninsular India on this account. Besides wheat, other grasses serve as hosts for this rust and they are common on the hills. More food can be produced by removing the ban on wheat. It is hoped that the ban will not be further extended. The interesting point is that samba wheat grown on the hills exhibits high field resistance to black rust and yet it is banned.

An attempt has made to indicate the losses caused to agricultural crops in general and the food crops in particular by plant diseases and also how by the adoption of various measures it is possible to reduce or control the diseases and increase production. But as already stated, everthing depends on the timely adoption of the correct methods of control. These differ in different diseases. Close cooperation between the grower and the pathologist will lead to the successful control of many diseases. The plant pathologist is not a magician and he cannot do much to save a crop after it has become badly infected.

The Socio-Economic Aspects of Maximising Crop Production

By

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'Agricultural efficiency is determined as much by the social, economic and legal status of the cultivator as by the technical perfection of implements, manures and soil. The two have necessarily to go together. The former reforms the cultivator himself and gives the needed incentive, the latter improves the soil, agricultural technique and farm equipment'.

The farmer at present is labouring under various economic handicaps like defective land tenures, uneconomic holdings, lack of working capital, a defective marketing system, unstable agricultural prices and under-employment. These are all disabilities which militate against the possibility of applying modern technological knowledge in maximising crop production.

Of all the socio-economic reforms suggested, agrarian reforms or the reform of land tenures loom large in the minds of people at presnet. The Land Tenure system in any country is the result of social, political, economic and technical environment and this system should be adaptable to cope with improvements in the technique of agricultural production. If the Land Tenure system gets fossilised and stands in the way of improvements in production technique, then it calls for reform. Any reform of the system. must aim at making the best of men, land, capital and management so as to ensure an ideal proportion between all the factors in agriculture and contribute to the highest output.

The problem therefore, is to find out whether our tenure systems contribute towards accomplishing maximum production. Before going into this however, mention may be made of an important reform already carried out by legislation, namely the abolition of the Zamnis, which has been acclaimed as a step in the right direction. Mention may also be be made of the other agrarian reforms suggested by various committees. It is not intended here to criticise the conclusions of this or that committee on agrarian reforms. But it cannot be overlooked that the recommendations are directed more towards attaining social equality or political ends than the attainment of maximum crop production. The problem seems to have been approached more as a political question than otherwise. Some of the reforms suggested are (a) redistributing the agricultural wealth, namely land, by dividing the large holdings among small-scale operators, (b) making farm owners of all tenant cultivators and (c) maintaining an upper limit to the size of farms.

We, as agricultural technicians cannot afford to look into the question from the point of view of political justice or injustice. We aim at land tenure policies for maximum crop production and we should be guided by this simple rule. Such policies will in the long run contribute to national welfare much more than the proposals to subdivide the land in an uneconomic fashion or put a ceiling on the maxium size of a holding or making owners of all tenants.

The land tenure systems in this State have been simplified with the liquidation of the Zamindaries which process is now already afoot. Barring some portions in Malabar and South Kanara, the land tenure system will be very soon wholly *Ryotwari*. In the *Ryotwari* system the products of cultivation are shared between the tenant when the land is leased, the land owner and the Government. The Government for all practical purposes is now out of the picture because the share of the Government as land tax has reduced itself to an insignificant amount with the increase in prices of agricultural produce. The main problem in the Ryotwari area is related to absentee landlordism, where the cultivator is not the owner of land. Fortunately in the Madras State the majority of cultivators cultivate their own land. It is only in the wet deltaic areas that absentee landlordism or tenant cultivation exist to some extent. The problem therefore cannot be said to be a major evil as it is in some other parts of the Indian Union.

Much is heard about the advantage of cultivation of land by the owners themselves but experience in this State as to whether the owner cultivator or the rented farms produce higher yields is quite the other way. In wet areas, where tenancy is most prevalent, it is the tenant who scores better returns and the owner operator is unable to compete with him. This can easily be explained as being due to the tiny size of the holdings they cultivate. The difference in efficiency as between an owner and a tenant in the cultivator of 3 or 5 acres of land is certainly not much when it is remembered that no difference exists in their methods of cultivation. Both of them lack the resources to achieve better production. On the other hand it is not unusual to find tenants operating a larger holding by leasing more lands when he finds his holding uneconomic. Further he has a responsibility to produce more as he carries a liability to pay a rent to the owner. In gardenland areas, where there is more of owner-cultivator, the owner and the tenant fare alike. One is therefore led to conclude that the magic of ownership as a factor of efficiency has rather been over-emphasised under the conditions existing in this country.

It is only when the owner with a large holding and adequate financial resources cultivates the land on modern lines that he is able to outbeat the tenant. Examples of such large-scale farming by an inflow of capital into landowning from trade and urban industry are

noticeable in all parts of the State, particularly in the Coimbatore district, where business profits have been ploughed back into agriculture on an extensive scale. The basic difficulty for owner operation seems to be the limitations of capital resources to bring about improvement, which alone will contribute to increased crop production. It is no good setting up a man as owner cultivator of a farm if he is starved of capital.

Owner cultivation has also other limitations. Apart from the holding being too small and uneconomic for the owner to cultivate it himself, it may sometimes involve the sacrificing of other profitable employment elsewhere on the part of the owner in his attempting to cultivate his holding. It may be that in certain extreme cases, he may lack the experience or the training to farm his own land. It is neither possible nor feasible for such owners to operate their lands as it will lead to disappointing results. It is well that such lands are left to tenants for cultivation.

The overall picture leads to the conclusion that very little can be expected towards maxmising crop production merely by shifting rights to the land from the owner to the tenant except to give the him the right to raise money on the mortgage of the land which right is now retained by the owner. Unfortunately this point of view is not appreciated by many of our agrarian reformers. For instance, we come across all over the State holdings adjacent to each other cultivated by owners as well as tenants without any noticeable difference either in their methods of cultivation or efficiency in farming. We rarely notice an instance where an owner can assert that he is a better cultivator than a tenant.

There is justification however, for the strong indictment that the landlord-tenant relations and the lease conditions fail to accomplish the objective of achieving maximum production from a a given piece of land. It has often been asserted and rightly too, that under the present tenancy system, the value of all benefits in farming tends to find its way into the pockets of the landlord in the form of higher rents. A tenant who improves the farm might be penalised by having his rent increased as a result of this rackrenting process. Another serious drawback of the tenancy system is the insecurity of tenure and the unreasonable disurbance of the tenant, having regard to the long-term nature of farming. Enquiries during village surveys have however revealed that eviction of the tenant is not the general rule but the exception. Though the duration of the tenancy is only for a year. it is renewed from year to year and there have been instances where the same tenant has continued for periods extending over thirty years. Another defect in the tenancy system is the imposition of restrictive covenants by the landlord in the lease, thus preventing 'freedom of farming' to the tenant.

Agrarian reforms are therefore called for and are more urgent in the field of landlord-tenant relations than in any other field. Legislation has to be directed towards (a) safeguarding against rack-renting by fixation of fair rents, (b) extending freedom of management to the tenant, (c) providing for compensation for unexhausted improvements at the end of the tenancy and (d) extending reasonable security of tenure and compensation for disturbance. These will provide the much-needed impetus to increase efficiency in production. All other talk of agrarian reforms like equal division of land or fixing ceilings to holdings will not contribute to increased production, but on the other hand, will only create instability in the industry and may have the opposite effect.

Mention was made earlier of the importance of capital and credit provision for agricultural development and maximum crop production. It is not here necessary to discuss the financial limitations of the farmer for agricultural development in this country. A large volume of information has been assembled by various committees, particularly the Banking Enquiry Committee, and a detailed discussion is found in their reports. The Credit agencies are the rural money lenders, the Co-operative agencies and the Government. It is well known that inspite of the recent drives, Government still play only an insignificant part in the matter of finance. The volume of credit supplied by the co-operative movement is also insignificant, though larger in volume than that supplied by the Government. The proportion of the rural population benefited by the movement was only seven per cent in 1928 and and about 12 per cent now, in spite of the quickened pace of expansion of the movement in recent times. The provision of credit by the Land Mortgage Banks is also a very slow process and the volume is infinitesimally small. The co-operative movement, in spite of half a century's progress in this country, has not succeeded in solving the rural credit problem and it cannot be expected to meet the financial requirements of the cultivators for some more decades to come. It is therefore not surprising to find the rural money lenders still playing an important part in the field of agricultural finance. Over 80 per cent of the credit requirements of the farmers are still provided by them. It is therefore natural that Government have recently proposed legislation to control the activities of these money lenders and to the extent they do not act as deterrents to their lending, the provisions of such bill must be welcomed. The legislation is based on the policy that so far as the money lenders continue to be an indispensable element in the financial system of the country, the remedy is to mend and not end them.

In this context, the present scheme for mopping up rural savings must be viewed with disfavour. From time imemorial rural savings are used to finance agricultural development in this country as there are no other sources of finance for this purpose.

It has been a good policy to allow capital formed in the countryside to remain there and if this is pursued a large portion of the agricultural credit requirements could be met by this capital of rural origin. There is a tendency however, in recent years for agricultural savings to flow into urban investment, thanks to the loose talk of irresponsible people on agrarian reforms. It is time, therefore, that we say 'hands off' the rural savings in the interests of agricultural development and maximising crop production.

Controlling money-lending or expansion of co-operative activity may help only as a temporary expedient in normal times, but in a campaign to maximise crop production it is doubtful whether these agencies would be able to play their part effectively and meet the needs of the farmer. Under existing conditions, it is difficult for even institutional lenders to extend credit for financing land imprevements, because not enough can be known by them of the productivity of those improvements. Many professional lenders and the Land Mortgage Banks, therefore hesitate to reopen mortgages or extend new or additional credit even for obviously desirable improvements like digging wells, drainage, &c. A strong financial organisation with very liberal outlook is called for and the need is persistent to organise an Agricultural Credit Corporation. This Corporation must inaugurate a long-term loan system at low interest rates to encourage land improvement. It. must also achieve credit expansion by shifting the emphasis from the basis of security to that of ability to repay. This principle has never been recognised in practice by any institution in this country, not even by the Land Mortgage Banks and it is here that the money lenders score over other institutions. The Agricultural Credit Corporation must take as much risk as a money lender in extending Credit. If the money lender is successful in his profession there is no reason why a Corporation should fail. Unless the rural credit system is revolutionised in this manner all talk of maximising crop production is mere idle talk.

Another incentive to the farmer in the economic field to maximise crop production will be stabilisation of agricultural prices. Fluctuating price levels with alternating periods of rising and falling prices have their counterparts in the general level of agricultural prices, and these in turn affect the fortunes of farmers from prosperity to adversity. Looking back for over half a century, it is possible to divide farming history into distinct periods of prosperity and adversity. One unfortunate peculiarity of these fluctuations in agricultural prices is that the lag in the movements of farming costs is more pronounced in periods of falling prices than in periods of rising prices. Naturally, therefore, the disadvantage of the lag to the farmer when the prices fall tend to outbalance the possible advantages when the prices move up and this situation is aggravated by the slow turnover of the farming industry.

A farmer's economy is therefore considerably upset by such fluctuations. Naturally he is diffident in investing money in long-range improvements which alone will contribute to maximise crop production. It is therefore of fundamental importance to stabilise agricultural prices to give the farmer a good return and to assure him that it will remain so. The need to stabilise agricultural pricet has been stressed by the Famine Inquiry Commission and the Policy Committee on agricultural prices. The principle involved has been recognised not only in India but the world over. The

UNO have said that 'excessive short-term movements in the prices of food and agricultural commodities are an obstacle to the orderly conduct of their production'.

If stabilisation of agricultural prices is necessary to maintain orderly conduct of production, stabilisation of prices at a high level is called forth to attain maximum crop production.

There is a tendency to ignore this view point, but as pointed out by the Krishnamacharya Committee on agricultural prices. "Any deliberate efforts, to reduce agricultural prices merely to safegaurd the interests of urban areas or of manufacturing industry will be at the cost of the standard of living in the rural areas which is already notoriously low. The unorganised character of Agricultural interests in this country has resulted in their case going by default in the past. A state of affairs in which urban prosperity, such as it is, has to be based on rural poverty cannot be tolerated in the future."

Other problems connected with maximisation of crop production are related to the size of holdings, their subdivision and fragmentation. Sporadic attempts at consolidation under Governmental auspices have been made in the past. Government view upto 1920 on this matter was that so long as subdivisions have to go on for one reason or another, any attempts at consolidation of existing fragmented holdings is bound to fail. Subsequently however, some co-operative societies were formed to assist in consolidation, but no tangible results have so far been achieved in this direction.

Co-operative farming is being recommended and various experimental co-operative farms have been organised in various States.

The report of the Indian Delegation on Co-operative Farming in Palestine has made it plain that Co-operative Farming on areas already occupied may not find favour. The land laws, the systems of tenure and individualistic attitude of the average Indian farmer may not contribute to their success The Palestine experiment succeeded as the Jews settled in new land aquired and laid out at great cost and sacrifice. Some New World activities on Co-operative Farming had a similar origin and they are confined to 'able, industrious and self sacrificing pioneering leaders' who were not originally agriculturists They took to co-operative farming as a new way of life, not merely as a means of living, In this context, Mr. Tarlok Singh's scheme of joint farming or joint village management must have a greater appeal to those interested in the problem. Though different from full-fledged co-operative farming, the scheme provides for the physical pooling of the land, dividing them into compact blocks to suit a family of cultivators who are to pay rent to the village community. All expenses towards improvement of land services are met first from the proceeds and from the balance, a dividend is paid to owners of land. Such experiments may be undertaken with the help of enthusiastic workers.

This brings us to a discussion of the future structure of the farming industry which will contribute to maximisation of production and increase efficiency. We are accustomed in this country to two general types of farming, the self-sufficient and under-sufficient type of farming over a larger area and a commercial type of farming over a limited area. In the intermediate stages, there are innumerable degrees and kinds of both self sufficient and commercial farming. Self sufficient or peasant farming is an inheritance from an age of relatively simple economic organisation. But throughout the world, this type of farming is greater importance than commercialised farms, which had led to farming being spoken of as a way of life: Self-sufficient farming was and still is a predominant feature of Indian farming and the farmers

are accustomed to seek the fulfilment of their wants through a village economy. This pattern of life has appealed to Indian philosophy In depressions or booms, these farmers have shown an extraordinary spirit of sturdy independence and self-reliance.

But we find the world changing. Farmers have felt the influence of the new commercial age, to technological developments and specialisation. But we are concerned here whether this self-sufficient pattern with all its accompanying satisfactions and advantages should be changed just to increase efficiency or to consider whether efficiency is not compatible with the present structure. It will be readily accepted that the latter view appeals to all. Wholesale and ill-considered adoption of mere technological efficiency is not advisable if it interferes with the spiritual and artistic cravings of man and destroys abruptly the general pattern of farm life. To submit therefore, to forces of economic or technological efficiency is to forget moral values and social welfare. But the same time, to cling stubbornly to the extreme forms of subsistence farming may be to deny that the world has changed or is changing and may constitute a social conservatism in an exagerrated form. We have to make a comprimise between these extremes.

Barring certain phases of mechanisation, it can be said that technology has not reached such a stage as to put the family or the subsistence farm at such a disadvantage as to lose efficiency. We know that the family-sized farm is capable of great efficiency, particularly in lifting water and also capable of benefiting from improved seeds and better manuring. One may still remember what Dr. Fay said about Northern Europe where 'it has been proved to the full that the highest degree of technical excellence is entirely compatible with family farming, but on condition that the land unit is the subject of special State guardianship and individual family effort is supplemented by group effort in purchase, processing and sale'. On the whole, therefore. there seems to be no present cause for assuming, as is done in some quarters, that family farms are inefficient and must be abandoned in favour of co-operative or collective farms to attain new goals either of social welfare or economic advantage.

Irrigation as a means for Maximisation of Crop Production

By

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The importance of irrigation to step up production of crops has been well recognised and of late numerous irrigation schemes have been started in various countries. In the Madras State, two major schemes viz., the Tungabhadra and the Lower Bhavani Projects are expected to be completed by 1952. Of these, the

former is intended to irrigate certain parts of the Ceded Districts, over an area of two-and-a half lakhs of acres, where nearly eighty percent of tht tract is composed of deep black soils. As the tracts are subject to very variable and uncertain rainfall, the average yield of crops is low. Chemical investigations conducted on the black soil of the tract and the water of the Tungabhadra river were in favour of irrigation, since the salt contents were low and no harmful effects like upward rise of salts or water-logging were noticed as a result of irrigation. Likewise, the performance of the crops under irrigation was satisfactory and very high yields were recorded in the several crops raised. It is thus clear that with the introduction of irrigation to this tract the production of crops could be considerably enhanced from the following considerations: (1) The cropping calendar could be started on the irrigated black soils in the month of June itself. Such a situation is not possible under the existing rainfed conditions, where the cropping calendar on the black soils of the ayacut area starts only from the month of July. Since the cropping calendar period is lengthened, it is possible to have a wider range of crops and this offers scope for greater choice of crop rotations. (2) By irrigation it is possible to fix definitely the time of sowing for each crop. (3) The irrigated black soils can stand heavy manuring and greater density of plants. (4) By irrigation, it is possible to introduce various crops new to this tract and (5) for maximising the production of crops under irrigation, consideration should also be given to pests and diseases to minimise their havoc either by breeding or by agronomic methods or with the aid of pesticides. Since the tract is subjected to both the South-West and North-East monsoons, consideration should also be given to the vagaries of rainfall which upsets the sowing and harvest operations of the crops and in addition the number of irrigations are also liable to be affected from year to year. In spite of such disadvantages, systematic light irrigation once a fortnight is found to be a feasible proposition on the whole. Finally, by irrigating two-and-a half lakhs of acres of the ayacut, production of both food and commercial crops are maximised to a considerable degree in the area and this goes a long way in meeting the requirements of the deficit districts of the Province, in addition to making the area self-sufficient. In the case of commercial crops like cotton, irrigation offers tremendous potentiality for the introduction of long-stapled American cottons, so urgently needed to-day in the Indian Union.

How Mechanisation of Agriculture helps in Maximisation of Production

By

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The Second World War, and particularly the Bengal Famine, have brought out poignantly how much Indian Agriculture and the Indian Farmer were neglected.

The emphasis in the previous regime was mostly on bullock and manual labour, which has landed the nation today in an acute food shortage. A few demonstrations with tractors and mouldboard ploughs were held, at a few research stations of this vast sub-continent and the visitors looked on it more as a tamasha.

In 1945, the total number of tractors in the whole of undivided India, including those that were brought in by the foreign armies were only about 13000, for an area of 220 million acres. The continued deterioration of the national food supply, the scarcity and high costs of farm labour, acute shortage of fodder and the high costs of maintenance of draft animals, have made the leaders and the agricultural engineers of the country think in terms of modernization of agriculture by mechanisation.

What is Mechanisation?: In simple language, it is nothing but man's mastery over nature in a systematic way and the use of its resources through mechanical devices. Mechanisation of agriculture is only a part of that process. It consists, in assisting animal and human labour in farming by mechanical power and ultimately in replacing both. Machine methods in farming, have made rapid advances in U. S. A., U. K., Canada, Australia and other Western countries. Today, mechanisation includes all operations on farms, like tractor ploughing, sowing and manure distribution with power drills and distributors, combine harvesting, water-lifting by electric or mechanical power, grading and processing of farm produce, transport by trucks and lorries, milking by electric milkers, spraying by helicopters and even kitchen operations by electrical and other accessories. The progress of nations, in the material sense, is judged by the amount of additional power available per worker in industry and agriculture. Prior to 1850, American agriculture was in the same condition as ours today. The machinery available per agriculture worker i. e. the additional horsepower per worker in dollars was only 17 in 1850. The value of the machinery per worker on the farm progressively increased to 30 dollars in 1870,

83 dollars in 1900, 190 dollars in 1920 and by 1948 the value of machinery per worker increased by 2½ times the value in 1920 and more than 25 times the value in 1850. The total value of farm machinery and equipment for production, privately owned, in 1948 stood at the colossal figure 8,338 million dollars (roughly 2,918·3 crores of rupees).

Table I below (furnished by Public Affairs Officer, United States Information Service, Madras) — gives sources of power used in ten farm jobs.

TABLE I

Operation.	Percent of work done with					
	Tractor machines		Animal drawn machines		Hand methods	
	1946	1939	1946	1939	1946	1939
Breaking land (plowing, listing, bedding) ...	82	55	18	45	...	...
Disking ...	85	57	15	43	...	...
Harrowing ...	77	43	23	57	...	...
Drilling small grains ...	79	49	21	51	...	...
Planting corn ...	41	13	56	81	3	6
Planting cotton ...	43	21	57	79	...	...
Planting potatoes ...	43	14	19	38	38	48
Cultivating corn ...	64	30	36	70	...	...
Cultivating cotton ...	45	21	55	79	...	...
Harvesting small grains ...	90	69	10	30	0·4	1

Even in 1939, the basic year for comparison, only planting of corn and potatoes and harvesting of small grains were done by hand methods. By 1946, the manual method in corn planting is reduced to 3%, potato from 48 to 38 per cent and small-grain harvesting from 1% to 0·4%. By 1946, the work done with animal-drawn machines is very much reduced and with tractor machines has increased. The percentages in 1946, of work done with tractor machines, in breaking land, disking, harrowing, drilling and harvesting are remarkable.

TABLE II

(Same source as table I)

Number of Tractors, Automobiles and Motor trucks in Farms.

(in thousands)

	Tractors	Automobilea	Motor trucks.
1920	246	2146	139
1930	920	4135	900
1940	1545	4145	1047
1945	2215	4184	1385
1948	3140	4934	1920

(Economic Almanac 1949)

The increase in the number of tractors is more than 12·8 times between 1920 and 1948. In the same period the number of automobiles is more than doubled and the trucks have increased more than ten times.

With the increase in power available per worker the output per worker on the farm has also increased. If the output per worker in 1939 is taken as the index number 100, 66·4 was the output in 1910, 86·5 in 1920, 89·8 in 1930, 103·5 in 1940 and 122·2 in 1946.

The gross farm income of the United States of America is raised with the increased availability of power.

Year	Gross income (in millions of dollars)
1910	7,352
1920	15,908
1930	11,388
1940	10,242
1945	24,665
1947	34,391

The increased use of machinery and power has made it also possible to extend the area under crops, as shown below.

Year	Total Farm Area (acres)	Farm area as percentage of total land area	Average Number of acres of farm land per tractor.
1	2	3	4
1850	293,561,000	15·6	...
1900	838,592,000	44·1	...
1920	955,884,000	50 2	3,881
1930	986,771,000	51·8	1.072
1945	1,141,615,000	59·9	515

United Kingdom: In 1946, 2,03,420 tractors served to cultivate 28,736,000 acres of crops and grass i. e. roughly one tractor for every 140 acres of land, including grassland. Tractors have further increased since then, to 3,00,000. Other machinery available for the farmer, are as follows (1946 census).

Name of machinery	No. available
Petrol and oil engines	178.490
Tractor Ploughs	178,950
Horse ploughs	303,240
Disc Harrows	65.200
Binders	149,500
Seed and Fertiliser drills	17 040
Pick Up Balers	1,900
Electric motors	54,260

Name of machinery	No. available
Corn drills	98,470
Tractor mowers	52,670
Horse mowers	175,640
Combine Harvesters	3,460
Milking machines	48,290

(L. F. Easterbrook, Agricultural Correspondent of the News Chronicle, London).

In 1946, the total annual value of farm produce is estimated to be £ 550,000,000 (Rs. 732·05 crores.)

U. S. S. R.: Until every recently, Russian agriculture was very backward in all respects. With its various plans in the last three decades, Russian agriculture has been modernized by mechanisation and other methods. The following table (from "The Socialized Agriculture of the U. S. S. R." by Naum Jasny — Stanford University Press) will show the progress achieved in mechanisation by the end of 1938.

FARM MACHINERY, 1928 and 1938

	Types of machinery	In 1928 (thousand units)	In 1938 (thousand units)
Tractors			
	Number	26·7	483·5
	Horse Power	278·1	9256·2
Plows			
	Primitive	4600·0	...
	Modern Tractor	9 3	493·5
	Horse	14000·0	5500·0
Drills			
	Tractor	0·5	265·5
	Horse	717·9	676·4
Grain Harvesters			
	Combines	0 0	153·8
	Binders, Tractor	0 1	10 7
	Binders, Horse	53 9	44·2
	Reapers and mowers	1299 7	896·2
	Threshers-complicated	5·6	130·8
	Threshers-relatively simple	552·0	297 4
	Beet Harvesters	0 0	19 3
	Trucks	0·7	195 8

The phenomenal increase in the use of farm machinery, especially mechanical power, in one decade is evident. The power of available tractors was increased more than thirty-fold, there were more than 1,50,000 combines and almost 2,00,000 trucks on Soviet Farms in 1938 as against virtually none a decade earlier. The change from inefficient indigenous methods to mechanised methods between 1928 and 1938 was little short of revolutionary.

MECHANISATION OF THE PRINCIPAL OPERATIONS IN AGRICULTURE 1928, 1932 and 1938

(percent of acreages)

Operation	1928	1932	1938
Plowing for spring crops			
Sokha	9·8	0	0
Plow			
Horse	89·2	81·0	28·5
Tractor	1·0	19·0	71·5
Seeding of spring grain			
Hand sown	74·5	51·7	12·8
Machine and horse	25·4	28 3	30·5
Machine and tractor	0·2	20·0	56 7
Harvesting grain			
Hand	44·4	35·4	8·5
Machine and horse	55·4	54·6	43·1
Machine and tractor	0·2	10·0	48·4
Combine and Tractor	0	4·0	48·4
Threshing grain			
Hand and other primitive methods ...	40·7	60·0	0·6
Threshers operated by horsepower ...	58·0		5·4
Threshers operated by mechanical power ...	1·3	40·0	95 0

Notable achievements in mechanised farm operations are, three-fourths of the total grain acreage was seeded by hand in 1928; by 1938 the proportion had been reduced to one-eighth; the acreage harvested by hand decreased from 45% to less than 10%; threshing by hand and animals disappeared.

An important item of activity in Soviet agricultural mechanisation is the establishment of Machine Tractor Stations, which are State organisations to perform farm operations with their machinery for the peasants' collectives. Previous to the Machine Tractor Stations, several attempts at mechanisation were undertaken by starting tractor columns machinery lending points, which were 56 in number owning about 1,496 small tractors in the spring of 1929.

The M. T. S.* was actually brought into being by an order of the Government in 1929, with a modest goal of serving one million hectares of cropped land by the end of the first year. The M. T. S. began functioning in February 1930. In 1930, there were only 158 M. T. S. in the whole of U. S. S. R. However, by greatly expanding the imports and by pushing up the domestic production of tractors, the organization of the M. T. S. was accelerated, as can be seen from the table below.

* Machine Tractor Stations.

Year	No. of M. T. S.	Tractors (thousand draw-bar Horse Power.)	Combines (thousand)	Trucks (thousand)	Tractor work (in terms of standard plowing) million hectares.	Combine harvesting (% of total grain acreage).
1	2	3	4	5	6	7
1930	158	87	0	0·1	...	0
1931	1228	681	0·1	1·0	...	0
1932	2446	1077	2·2	6·0	20·5	0
1933	2916	1758	10·4	12 3	35·2	0 7
1934	3533	2754	15 2	19·5	62·5	1 9
1935	4375	4282	29·3	27·8	100·5	6·9
1936	5000	5856	64·9	43·2	164 6	21·3
1937	5818	6769	104·9	60·3	202·8	33 7
1938	6358	7437	127·2	74·6	206·2	—
1939	6498	...	141·0	...	210·7	—
1940	6693	8292	148·0	40·3	211·3	43·0

From 158 Machine Tractor Stations in 1930, with tractors possessing a total of 87000 draw-bar horse power, the number has increased to 6693 stations in 1940 possessing tractors of total draw bar horse power 8,292,000. Similarly, the number of combines have increased from nothing to 148,000 and trucks from 100 to 40,000 during the period 1930-1940.

Europe: Under the caption "Agricultural Mechanisation and Europe's Economy", Mr. Montell Ogdon has given a survey of the progress of mechanisation under the European Recovery Programme. (Foreign Agriculture, March 1949). 21000 tractors were expected to be produced, in the year 1949-50 under the European Recovery Programme. The U. S. Farm Machinery Survey Mission has reported that there was a genuine need for farm machinery in those countries for efficient utilisation of land. These European Recovery Programme countries, have further committed themselves to reduction of draft animal production, increase of meat and milk animal production and at the same time to further expand the food crop acreage by mechanisation.

The Organisation for European Economic Cooperation has planned to achieve increased yields per acre of bread grain crops, by 1952. In Denmark, the increase in yields is expected to be by 20% over the prewar yields, in France by 28%, 31% in Greece, 9% in the U. K., 8% in Turkey and 7% in Italy: to be achieved by increased mechanisation and other modern methods of crop production.

Some of the important findings of the Organisation for the European Economic Co-operation Sub-Committee and the U. S. Farm Machinery Survey Mission are that the reasons behind the urge to mechanize are three-fold viz (1) realization of the importance of machinery in improving output; (2) desire by farmers to reduce costs; (3) necessity of solving the labour problem.

Farming machinery of the countries participating in the European Recovery Programme is proving to be an important factor in putting the agriculture of these countries on a more productive basis. In the European Recovery Programme countries there are quite a good number of small holding farmers along with many medium size and large holding farmers. Mechanization of these three classes of farms is taking place at a fairly good speed.

From the above data, the following conclusions emerge; (1) that mechanisation definitely helps crop production; (2) that mechanisation of farm operations and increased use of electric power for various processes in the farm house, the dairy, and the poultry are essential to increase the agricultural efficiency and output; (3) that by mechanisation and increased application of power, the drudgery attached to the slow and ineffective hand-methods is removed; (4) that by mechanisation, the employment of less suitable types of labour like women and children can be eliminated.

From the national standpoint, it is essential to look after the well-being of those engaged in this huge industry. The conditions of rural population and the agricultural workers, generally all over the world, and particularly in India, are far from enviable. Our agricultural workers have not attained even that quantum of standard of living enjoyed by those in other vocations in the cities. The solution for raising the standard of living of these workers, lies in mechanisation and making more cheap power available for them.

Our public opinion on mechanisation: With the above conclusions, let us examine the public opinion in our country. There are three schools of thought on the subject. One asserts that Agriculture is a way of life and that it should not be disturbed. Some of their important misapprehensions are mechanisation leads to reduction of draft animals and hence less farmyard manure for the fields.

However, well it may be cared for, there is a limit to the output of the bullock, the maximum limit being ½ h. p. Only a certain percentage of the total area, can be set apart for fodder purposes. Under these limitations, it is futile to continue to depend on the inefficient bullock for our farm operations, while the day-to-day maintenance costs for the same are mounting high. Even the small garden tractors, of 5 to 8 H P. are definitely more efficient than the best bullocks. So, by planned displacement of the bullock power, by machinery, not only is the crop production increased, but also the entire fodder crop of the land can be diverted to feed more and improve the breed of milk cows, which will yield greater quantities of milk and milk products. The increased number of milk cattle will also make good the possible loss of manure due to the

reduction of bullocks. There are also other commercial animals, like sheep and goats which if cared for more, will add to the wealth of the farmer and supply manure to his fields.

The second reason put forth is that mechanisation increases unemployment. The truth is, in our country, due to lack of opportunities by way of alternative sources of employment, there is over-crowding in the agricultural labour force; over-crowding by misfits, inefficient and superfluous workers. The result is high costs of agricultural production and low yields due to adoption of inefficient manual methods.

Contrary to the above apprehension, in the U. S. A. the strength of agricultural labour force has increased along with the wages, in proportion to mechanisation. While the total number of persons engaged in agriculture in 1850 was only 5 millions with increased mechanisation, the total has increased to 6 millions in 1870, 10 millions in 1900 and 11 millions in 1920. Of course, these workers would be more skilled and intelligent in handling agricultural machinery. In the year 1850, just preceding the agricultural machinary era, wages on the farms were from 8 to 12 dollars per month with board. The average farm wage rate for U. S. for subsequent years, has increased manyfold.

Year.	Monthly wages without board (in Dollars.)
1	2
1866	15·5
1874	17·1
1890	20·02
1902	22·12
1919	56·77

(1926 Year Book, of the U. S. Dept. of Agriculture)

The third reason put forth is on grounds of sentiment. In the world of hard realities, sentiment has no place.

There is a second school of thought, diametrically opposite to those of the first, which urges speedy mechanization and supply of maximum power to agriculture, at all costs. Some of the arguments put forth are that the goal of a nation, as of an individual is to obtain the maximum results with the least effort; the whole economic progress of mankind consists in getting more production with the same labour; it is for these reasons that the wheel and the wagon, rail-road and motor truck were invented and above all, agriculture must be viewed as an industry and all devices that increase the output per worker must be made available to this most important primary industry of the country.

The third school views, along with the second school, agriculture as an industry, feels that greater power per agricultural worker must be made available, in this industry along with others but thinks that mechanization, in India, has only limited application in such operations, as cannot be undertaken by bullocks and man, efficiently, viz., (1) power irrigation; (2) breaking up of new lands; (3) eradication of weeds; (4) agricultural in sparsely populated areas; (5) harvesting and threshing etc., where seasonal shortages of labour, may lead to losses due to untimely operations and (6) other large-scale constructions of contour bunds, embankments, drainage and irrigation channels etc.

It is true that the high-powered tractors are pre-eminently suited for those large-scale operations. But the modern trends in Agricultural Engineering are to supply multipurpose tractors and implements, to suit the different types and sizes of farms and to be useful under varying soil, crop and other conditions.

The impression that the tractor is of limited use in Indian Agriculture, might have gained ground because of the use of large-powered tractors by the Povincial Governments, acquired from the Army surpluses. To clear such wrong impressions, to determine the various uses in Indian Agriculture of tractors and implements, and to build up public enthusiasm on a scientific basis, experiments on an All-Mechanised Farm have been started recently in the Agricultural Engineering Section, Coimbatore. These preliminary trials have shown that the tractor can take up most of the operations in our agriculture. The experiments are being continued and will be conducted over a 3-year period with a view to further examine the following :

Problems : (1) Costs and other economic aspects ; (2) relationship between the drawbar pull required for the particular implements and the mechanical structure of the various soils of the State of Madras and (3) effect on yields.

These experiments are designed also (1) to determine the limitations of the imported tractor implements under our climatic, soil, crop and other conditions. And to advise the agriculturists, on the selection of the right type of tractor with a set of imported implements suitable for a particular crop, soil and other conditions for 'Standardization of the Horse Power and the minimum set of implements required' for the various regions and crops of our Province and (2) to design or modify bullock implements to hitch them behind the tractor.

Some of the other important handicaps against the popular use of the tractor in our agriculture are lack of (1) necessary capital, (2) required number of machines; (3) machines suiting our

requirements; (4) cheap fuel (5) necessary skill and machine-mindedness; (6) workshops and servicing facilities and (7) alternative sources of employment to the workers displaced from agriculture.

These may now be examined to surmount, to devise means, taking Madras State itself. It is acknowledged by all, that the means of production in our agriculture are very inefficient and slow. Our agriculture is in the same condition as American agriculture was in 1950. Hence, we have to make up for this time-lag of a century by the adoption of planned mechanisation. With that end in view, holdings can be roughly grouped into three- All pattadars paying kist above Rs. 30/- and upto Rs. 1000/- are grouped as large-size holders; similarly those paying kist Rs. 30 - and below, but above Rs. 10 - are treated as as medium size landlords and all others paying less than Rs. 10 - as kist are small-size land holders. Thus there are about 4,14,721 large holdings with a total acreage of 8,799,599; 1,156,992 medium holdings covering a total acreage of 7,585,557 and 5,118,111 small holdings with a total acreage of 11,254,348 acres.

Madras is leading in the field of mechanization too. Our activities in this field, began from 1946, with the establishment of District Tractor Stations by the State. In this brief period of barely four years, along with the achievements under land reclamation, improvements to tanks, intensive cultivation and other activities, the Agricultural Engineering Section of the Department has roused the enthusiasm of the ryots to a high degree.

With all this, only the fringe of the problem is touched. To cut short the time lag and to place this state on a par with the progressive countries of the world, more State aid in the inital stages, is essential.

If the industry is viewed from another angle viz., the amount of Horse Power of machinery available per agricultural worker, the necessity for immediate State aid will be quite plain. In the year 1939–'40, for the total labour force of 4,774,000 on the farms of this state, there are oil engines, electrical pumpsets, sugarcane power crushers and tractors, of an aggregate horse power 73,685, which works out to roughly 0·015 horse power per worker. By 1947–'48 the total horse power of the above machinery has increased to only 85,582, thus making available per worker about 0·013 horse power of machinery. This increase in the horse power is mainly due to the increased activities of the Agricultural Department.

This is the largest industry of our State, with maximum capital investment and the one single industry employing maximum number of people.

Table showing the investment and gross income in Madras State during 1939—40 and 47—48.

Items.	1939—40		1947—48	
	Total Investment in Rs. Crores	Gross income in Rs. Crores	Total investment in Rs. Crores	Gross income in Rs. Crores.
Agrl. Land Cultivated area only (excluding Forest.) ...	1000	166	2127	498
On Live Stock ...	66	50	212	200
On Machinery, Ploughs and tools ...	21	...	56	...
Total ...	1087	216	2395	698

Agricultural Labourers — 4,774,000 (approx. from census '31)
Total engaged in Agriculture including land owners — 12,570,000 (From "Rural Problem")

In a broader sense, it is the only industry devoted to the production of food and of raw materials used primarily for food, shelter and clothing.

In America in 1948, when the total value of farm land was 62,813 million dollars, the investment in farm machinery and equipment was 8,338 millions. which is about 13% of the value of the land, whereas in our State, in the year 1947-'48 the value of the agricultural machinry etc., was only Rs. 56 crores as against the land value of Rs. 2127 crores which is only 2·63% of the value of land.

Hence, it is our paramount duty to modernise the means of production in agricultural practice. As the problem is a huge one, it is to be accomplished only in stages. In the first stage, the four lakhs and odd large holdings mentioned above have to be equipped with suitable machinery and equipment. The tractor and implements have to be standardized, by exhaustive trials and studies, with reference to the crop, soil and other factors. And in the initial stages, the State have to supply them at fair prices.

Similarly standardization of the tractor and set of minimum implements has to be undertaken by the Government, to cater to the requirments of 1,156,992 medium size holdings, which will be mechanised in the second stage-

When once the types of tractors and implements are standardised, with reference to the size of the holding, crop, soil and other factors, the demand for the same, among 1,571,713

farmers (large and medium) is certain. This is the potential market. The panel on Automobiles and Tractors constituted by the Government of India, in 1945 under the Chairmanship of Mr. K. C. Mahindra, has reported, that 4000 units of one type of tractor is considered an economical volume for purposes of assembly and that Government should take on the responsibiility for initiating action in regard to tractor and agricultural implement manufacture. Here is the solution for mechanising all the farms. By the manufacture of tractors and implements in the province, large sums of money that have to be spent annually for imports will be retained, machinery at fairly low costs can be made available to suit the conditions of the different types of farmers; further stimulus to the industrial expansions would be given and the superfluous labour, that are now depending upon agriculture can be more advantageously diverted into fruitful channels.

Mechanisation of the 5,118,111 small holdings, of the State with a total acreage more than 1½ times that of large holdings, has to be undertaken in the third period of development, with State aid. Agricultural Engineers and manufacturing firms of the West are now engaged in solving the mechanical problems of the small farmer, to supply him with low horse power tractors mounted implements and other accessories at a cost suiting his purse. Research on similar lines, to solve the problem of our small farmers has to be undertaken and designs suitable, have to be evolved, to initiate the third stage development.

By the beginning of the third stage of development, our agriculture and industries, can be expected to be more prosperous yielding large revenues to the State. Expansion of agricultural machinery industry, to cater to the small farmer has to be taken up and they too have to be brought in line with the others, by supplying on instalment purchase and other systems.

Alternatively, these small farmers, can be brought under Co-operative Agricultural Machinery Societies. Or their machinery requirements can be met by increased number of District Tractor Stations of the Government, and through the agency of private contractors under State Control.

For the successfull completion of these programmes, and to ensure low costs of operation of the power mechinery on the farms, cheap fuel supply is to be assured. The cost of petrol is prohibitively high and petrol engines and tractors, do not appear to have a future, until geological explorations reveal fresh and plentiful supplies of oil in our country. Though diesel engines are a little intricate, they alone hold out hope for the present, to our farms, since diesel oil is comparatively cheaper.

The Union Government, have to negotiate with the oil companies to restrict their margins to the bare minimum on all diesel fuels and power kerosene for farm purposes. The "Agricultural Machinery" Journal, June 1950, announced the details of Ferguson Lamp Oil Tractor, designed to run on Zero Octane fuel after it is started on petrol. Further researches on the use of lamp kerosene oil, and other cheap indigenous oils, as fuels for farm engines, have to be undertaken immediately in our National Engineering laboratories.

It is often pointed out that our rural population is lacking in the necessary skill and machine-mindedness. But it is from the ranks of the same rural folk, lakhs of skilled mechanics, drivers and workers for other mechanical trades were drawn for the World War II. They have not only picked up the new trade in the shortest period but have also won the war. In recent years a few farmers of the province have gone in for tractors and not a few of them are being manned by the farmers' sons. Given the proper facilities to learn, the Indian farmer will never lag behind his counterparts of the West. It must be insisted that every firm importing tractors and implements should provide ample workshop facilities spread over the whole of the State, and should train the farmer or his son in the manipulation and maintenance of the machinery purchased from the firm. The facilities by the commercial firms can be supplemented by taking in for training, batches of nine farmers, at the two Government Tractor Workshops.

To-day commercial Firms, are taking advantage of the public enthusiasm in favour of agricultural machinery, by trying to dump on the ryots, their machinery with very meagre or no retail stores for spares and servicing facilites, This is likely to end in enormous losses to the ryots, by improper selection of machinery and machines lying idle for want of spares and servicing facilities. If the above contingencies arise, they will lead to a positive set-back to the mechanisation programme of our agriculture. To avoid both, it should be stipulated, that every machine before it is sold to the farmer must be subjected to exhaustive tests in the Government Agricultural Engineering laboratories as to their suitability to our provincial aricultural practices. Similar tests are conducted at Nebraska in the U. S. A. and relevant test data are published for the information of the farmer. Imports and sale of agricultural machinery must be restricted to the approved models only.

The second condition to impose on the importing firms is, when once a particular machine is certified to be suitable for a region, the firm should open a chain of servicing stores. The efforts of Messrs. P. S. G. & Sons, Peelamedu in this line are worth mentioning. In addition to their factory at Peelamedu, there are their retail stores and servicing stations for their machines in a few

taluks of the Coimbatore District. "Farm Implement Retail Stores" is an essential adjunct in the mechanisation programme, as is evident from the following data on the retail stores in U. S. A.

Year.	No. of retail stores.
1929	12,242
1935	9,637
1939	10,499

(Statistical Abstract of U. S. A. 1949).

Elsewhere. it is pointed out, that progressive mechanisation of agriculture instead of creating unemployment, has increased the total labour force of the industry in U. S. A. Similar increases in employment are noticeable in the U. K. as well, from the table below:

(From "Agriculture in Britain" issued by Reference Division, Central Office of Information, London, W. 1.)

Employment in Agriculture in Great Britain (1936—1949)

	(in thousands)			Women's Land Army.
	Total	Males	Females	
1936, ...	751	657	94	...
1938, ...	697	610	87	...
1940, ...	712	602	110	8·8
1942, ...	824	627	197	59 0
1944, ...	863	647	216	78·0
1945, ...	887	683	204	65·3
1946, ...	889	732	157	33·8
1947, ..	892	746	146	26·9
1948, ...	850	703	147	25·4
1949, ...	852	717	136	16 3

* Great Britain. The figures include all those in full-time employment in Agricultural, Horticultural and timber work.

It is a natural consequence of planned mechanisation, to bring in more land under cultivation and develop some of the neglected agricultural pursuits, like dairying, horticulture, vegetable gardening, fruit gardening, poultry and so on, engaging thousands of skilled workers. The chain of retail stores and servicing stations for agricultural machinery, spread over the whole State, the factories for that would be started for the manufacture of various types of machinery from tractors, implements, sprayers to electrical incubatores, milking machines etc., and the mechanised small scale industries would absorb all the rural population, and give them full employment, instead of the under-employment of the present times. Hence, it is evident that to solve the food shortage in the country, extensive and intensive growing of various crops is an immediate necessity.

How crop production can be increased in our State: It can be achieved by (1) extending the area under crops after reclamation with bulldozers, tractors and tractor-drawn implements; (2) increasing the irrigation facilities and (3) intensive cultivation in those areas that are already under the plough, with the aid of modern agricultural machinery.

A major portion of the agricultural engineering activities of our Department, through the district tractor stations, for the last four years, will come under the first category mentioned above. Our ryots have utilised the services of the departmental machines, to the maximum, for bringing greater areas of fallow lands under cultivation. Realigning the levels of fields under private ownership to suit the wells located in them, with the aid of bulldozers, in the Coimbatore District; the excavation of private tanks to store greater volumes of water for irrigation of paddy fields of Malabar, the spring channel excavation in the Chingleput district and removal of sand and silt from the fields affected by the recent cyclone in the northern districts are a few operations of outstanding importance, which were undertaken by the departmental tractors. These and the various other works undertaken by the departmental machinery are of such nature, that they could never be expected to be undertaken by manual labour and even if undertaken by hand implements, it should be at prohibitive cost, extending over long periods.

Till now, the extension of area under crops was left to private initiative, and the State has given out on hire machinery to such of the ryots as had asked for them. There might be a good number of ryots in the State owing large areas of weedy or fallow land or scrub jungle, who due to straitened financial conditions, could not go in for hiring the departmental machines. We cannot allow this awkward situation to continue. The reclamation of these areas has to be undertaken by the State and the hire charges may be collected in instalments from the ryots beginning from the end of first crop year. There are also large tracts of scrub jungle or fallow lands fit for crops, in some districts. These should be reclaimed, and weeds should be eradicated by tractor ploughing and then handed over to ryots, for raising food crops. Nominal charges for reclamation, may be collected, in these cases on an easy instalment system.

Increasing irrigation facilities — wells: Large river projects are being developed along with the renovation of irrigation tanks to make available enough water supply for the crops in areas which until now are dependent upon an uncertain and meagre rainfall.

Irrigation wells are the third biggest item, in our State under this head. Every district, including those under the three major irrigation systems, Godavary, Kiishna, Cauvery have wells which are supplying water for crops. There are, according to

the "Season and Crop Report – 1945 – '46" about 85,877 irrigation wells in our State; of which about 519,635 are located in the six districts, of Chingleput, North Arcot, South Arcot, Salem, Tiruchirapalli and Coimbatore.

There is still ample scope for bringing more acreages of crops under well irrigation, by tapping underground water resources. Of the three major water supply sources, wells can be dug the cheapest and in the shortest time. Also. it may be a long time before the large river projects are developed and water is made available for irrigation to such of the areas that are even now dependent upon the vagaries of rainfall, with consequent uncertain and indifferent yields of crops. Hence, a systematic survey of the underground waters have to be undertaken with the aid of modern scientific instruments; sites for wells have to be located accurately and dug by modern machines which while ensuring low costs, will complete the work in the shortest time. For purposes of planned development and to avoid losses, this task has to be undertaken by the State.

Water from wells can be lifted efficiently by power, either mechanical or electrical. The efficacy of electric power for water pumping is well known. Out of the 8 lakhs and odd wells of our State, not to speak of the fresh wells that might be excavated in future, only a few thousands might have been fitted with electrical and oil engine pumpsets. Development of an electrical grid, to make the energy available to all the wells and the villages, is an immediate necessity. Assurance of timeliness of operations, like threshing, processing, grading etc. of crops, at low costs, is a great incentive to the farmer for maximum production, and cheap electrical energy is the only aid for this. Every progressive country, that has aimed at maximising its crops, has supplied electrical power to agriculture, on a preferential basis, at very low tariffs. By the adoption of such tariffs which will stimulate the agricultural load, the load factor, the diversity factor and the power factor of the supply systems have been found to be improved to the advantage of the system. So, there is considerable scope and necessity for the revision of the provincial electrical tariffs for agricultural purposes.

Replacement of bullock and manual labour, in lift irrigation, by mechanical and electrical power, while assuring continuity and efficiency, will make available larger quantities of water in time, to the crops. So this replacement should be completed, in a targeted period of years. It can be achieved only with State aid.

Maximisation of crop production by intensive cultivation: As already pointed out, modern agricultural machinery is utilised in the Western countries not only for reclamation of waste lands and extension of areas under crops but also for day-to-day operations in agriculture.

In recent years, the average size of holdings in the U. K. and the U.S.A., is coming down and the number of small holdings is on the increase. The trends in the present time agricultural engineering are, a tractor for every farm and an implement for every operation. The high costs of labour and maintenance of animals is the experience of both the small and large holding landlords of our State. The margin of net income appears, therefore, to be too low to offer sufficient incentive for increasing the yields.

In areas, like the Ceded districts, the rainfall is meagre and all of it will come down in a brief period either in time or late. Often, preparatory cultivation, sowing etc, have to be done swiftly after the first rains. Hence all the area is either not cultivated or cultivated imperfectly.

In the deltaic districts also it is the same story; land is either left fallow or weeds are imperfectly removed due to the high costs of the prevailing methods. Partial success in deep ploughing is possible only after a number of ploughings with bullocks. In some other areas, even with the availability of irrigation facilities the ryots could not be benefited, due the irregular levels of the fields. Our manure spreading methods are inefficient and our seed rate in broadcasting is higher, compared to those obtained with machines. In all those cases, the yields of our crops are low and at high costs.

Mechanisation comes in handy by way of perfectness of operation, larger turnover per day, low costs, timeliness and increased yields.

Appreciating the importance of machinery in agriculture, enquiries about a suitable tractor and set of implements, are being sent in, by the ryots, in increasing numbers, to the Agricultural Department.

To sustain their enthusiam and to convince them with data based on exhaustive trials, under actual farm conditiods, studies on All Mechanised Farm", have been started at Coimbatore. A thirty-acre plot of the Millet Breeding Station, representative of, the provincial medium-holding class of the rain-fed type is selected to collect data on costs, yields and other aspects as mentioned previously.

A "Calendar of Operations" is drawn up for the year, in co-ordination with the the Millet Specialist and the selection of machines and implements is made sufficiently in advance. The studies are in progress and will be continued over a three-year period, to obtain data on the effects of mechanization, on our agriculture. A few of the reults obtained till now are furnished below.

"ALL-MECHANISED FARM"

Studies on the draft requirements of the various tractor implements on different soils.

Sl. No.	Date	Type of soil	Field No. and Plot No.	Operation	Implement	Tractor	Depth	Width	Dia. of disc	Draft in lbs. With load	Draft in lbs. Without load	Draft in lbs. at head lands	Running costs acre	Remarks
1	12-2-1950	...	...	...	Two-furrow disc plough	Massey Harris 20k	...	...	...	890	...	...	9-9-6	Though not coming strictly under the experiments, are interesting and contributory.
2	11-2-1950 10 A. M.	...	F. 36-A	...	Massey-Harris 3 disc plow No. 504	W. 6	...	...	...	1287	...	300	5-7-9	
3	13-2-1950 11 A. M.	Black sandy loam	F. 37-A	...	3-Disc plow	W. 6. with pneumatic wheel	...	...	...	1st gear 1370	314	913	5-7-9	
4	28-4-1950	Red loamy dry land	F. 11 MBS	Covering F. Y. Manure	28-Disc Harrow (Ransome's)	T. D. 14 A. No. 2	3-5"	8-0"	1-8"	gear 1st 1730 2nd 1688	...	...	...	*The wheeled type tractors could not negotiate in the ploughed lands, for this operation. Hence it was replaced by a crawler type one. The turnover per day is 19 acres.
5	1-5-1940	Red dry land	F. 37 Plot No 1	do.	28-Disc Harrow (Ransome's)	T. D. 14 A No. 1	3-25 to 3-5"	8-0"	1-8"	2nd gear 1449	...	824*	...	
6	1-5-1950	Black cotton soil (dry land)	Field No. 27 Plot 2	do.	do.	do.	do.	8-0"	1-8"	2nd gear 1575	...	...	...	
7	10-2-1950	...	Filed No. 7 1 5 acres	Sunhemp plowing in Sugarcane Br. Station	Three Disc.	W. tractor with iron wheel at the rear	6½"	...	...	1st gear 1614 2nd gear 1189	884	735	...	Remarks on items 1, 2 & 3 hold good.

The implements used in all theses operations are modern tractor implements, which are designed for perfectness of operation and increased turnover per day. From the readings, obtained under draft, it is clear, that the bullock and man are far behind. So continuance with such low power aids will only lead to poor results.

Hariali is one of the worst weeds, which is common in black soils. It develops a mass of roots which run through the soil in all directions, creating a mat to choke the crop plants. The depth of the matted roots varies from 10 to 12". To eradicate this weed, the soil should be turned to expose the roots to the sun. The depth of ploughing should be at least 10". It is a very hard task for both man and animal. Recent experiments on weed eradication with tractor implements at Field No. 37, Central Farm, Coimbatore have brought out the following results. Cost of digging by crow bars per acre, worked out to Rs. 263/- whereas a D. 6 Tractor with 28" four-disc plough on another plot of the same field gave a turnover of 4.4 acres per an 8-hour day. The eradication was found to be 90% perfect, the average depth of ploughing being 9" and the running costs per acre worked out to Rs. 6/- only. Comparative studies on yields etc. will be continued.

While following the "Calendar of operations" the under-mentioned factors are also kept in view :—

1. That our crop practices like the inter-row spacing and intermediate applications of guntaka etc. are perfected for bullock and hand implements. Introduction of sudden drastic changes in these practices should be avoided;

2. Our ryots are willing to go in for a tractor, though it is costly but are rather reluctant to go in for the costly imported implements whose performances they are not sure of;

3. Some of our agricultural implements like the guntaka, bund former and the mechanical seed drill, which are unique, are so well known to the ryots, in their construction and performance, that the possibilities for modifications to hitch them behind the tractor have to be explored, to reduce the capital investment. and to create confidence. Also most of the village black smiths can handle their servicing and repairs.

For irrigated crops, bunds are being formed by the bund former, drawn by a pair of bullocks. These bunds divide the field into plots of 10' by 30' with a trench for water flow between every two longitudinal rows of plots. Inspite of the use of dead weight and pressure by the man at the handle, the formation of the bunds is not perfect and the acreage bunded per day, is also low. Thus it is resulting in inefficient utilization of the meagre water

supply. To overcome this difficulty and to increase the turnover per day, two bund formers with 10′ spacing between were bolted below an angle iron frame mounted on wheels. This has been tried by hitching behind the tractor. The formation of bunds was found to be more perfect. While the cross bunds were being formed, one of the formers would be removed and the other would be adjusted to go behind the rear wheel of the tractor thereby minimising the manual labour at cross cuts. By these preliminary trials, it was concluded that the bund formers could be hitched behind the tractor to increase the turnover and to minimise the idle hours of the tractor. A more efficient utilisation of the meagre water supply for irrigation could also be achieved.

After the first few summer ploughings, it is the practice of our ryots to run the guntaka twice or thrice after the rains, to cut the roots of the sprouting weeds, without disturbance to the top soil. This guntaka is drawn by a pair of bullocks or two in some cases. Though this is a very light operation requiring low draft, often the turnover per day is so low that the ryots are being forced to complete the job imperfectly or leave some land fallow. Utilizing the principles of construction of the guntaka, a similar implement six feet in length was designed and bolted to the same angle-iron frame as above and hitched behind the tractor. Preliminary trials with it in July 1950 have proved that the cutting of the roots of the sproutings is perfect and the turnover is increased many times. The draw bar pull required for the tractor guntaka in the black soil area of the Millet Breeding Station, Coimbatore is 1400 lb; similarly in red soil area the draft is 912 lb. Further trials on this design are being continued. When this simple implement is perfected, the tractor owner who can obtain it at a very low cost, can not only operate the guntaka on the whole area but can also put his tractor to greater use in agriculture.

The evolution of the standard angle-iron framework, which will take in, either the bund-former, the guntaka or any other implement of ours, is also being worked out at the Research Engineering Section. By possessing either one or two sets of such standard framework, more tractor working hours in our agriculture can be achieved, at minimum capital investment. The operations will be more perfect and in time, resulting in increased crop yields.

Utilization of the tractor power, to run the processing machines, like thresher and chaff cutter, to run the pumpset at the well for irrigation, and the tractor with a trailer as a means of transport are being resorted to by some of our ryots. With the increased popularity of modern machinery among our agriculturists, in the coming years; along with increased yields and increased profits, a more prosperous agricultural community will emerge.

With a view to achieve planned and successful mechanization of our agriculture, the following additional proposals are made. These have to be accomplished in stages, by the end of about fifteen years.

During the 1st stage: 1. Extension of research in Agricultural Engineering by the establishment of three more stations, one for the Ceded districts, one for the Northern zone and one for the Central zone of the State.

2. "Extension service" branch for engineering, manned by trained agricultural engineers.

3. Starting of large-scale District Demonstration Farms, equipped with power drive, suitable machines and implements with workshops and servicing facilities.

4. Initiation of Degree courses in Agricultural Engineering in one of the Universities of the State, to supply the officers to man the various schemes.

5. Training in Agricultural Engineering of a selected number of candidates annually, in a few of the Polytechnics of the State Engineering. At the end of the training, the successful candidates will be awarded the diploma in Agricultural Engineering, similar to the diploma in Automobile, Radio or other branches of engineering. These licenciates are to man the lower categories of posts.

6. Training the rural population in maintenance and running of agricultural machinery;

7. Arrangement of sale of tractors and implements etc., on easy instalment system to the ryots ;

8. Encouragement to private capital to start in the different regions, factories for the manufacture of implements.

In the 2nd stage: In addition to the extensions to the activities of the 1st stage, the following new programmes should be initiated.

1. Establishment of a factory for manufacture of medium-size tractors and suitable implements ;

2. Tractor and implement testing stations.

3. Development of research stations with a view to cater to the small holding landlords ;

4. Establishment of co-operative agricultural machinery and implements societies ;

5. Extensions of servicing workshops and retail stores; with a view to establish one servicing centre for one revenue firka;

6. Extension of cheap electric power to the villages.

In the 3rd stage: of development, in addition to further extensions to the items of the above two stages.

1. Increased activities of the State Extension Service;

2. Establishmet of Factories to manufacture, dairy, poultry and other appliances of the farm;

3. Establishment of factories, to manufacture the Tractor and other machinery requirements of the small holdings;

4. Extension of the retail stores and servicing stations to form a net work and there should be one such station for every group of five villages in the State.

Role of Plant Breeding in a Scheme of Maximising Production of Crops

By

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Introduction: The ultimate aim of all work on crop improvement is the production of the best crops, the chief test of superiority, implying, besides, the greatest return to the grower. This, in turn, is dependent upon the increased yields realised and the economics of production.

Although a good many of the crops now made use of for food and clothing for man and fodder for cattle have been in existence from very remote times, recent studies have shown that there is still a great scope for improving them by producing varieties that are more efficient in their use of plant nutrients, give the greatest return of high quality produce per unit area in relation to costs of production, besides a greater immunity against diseases, insects pests and adaptability to the needs of the grower and consumer. In achieving these ends the plant breeder has played a very large role.

Breeding—Art or Science? Whether plant breeding is a science or an art is still a subject of controversy. Many still hold the opinion that breeding is an 'art'. But that breeding is also scientific can be seen from the large number of achievements made since Mendel's principles of genetics have been applied to the improvement of plants and animals.

Nevertheless, the really successful breeder does possess a kind of 'instinct' to discover and integrate the very small and useful attributes of the crop plant which he is dealing with and a knack for getting the desired result in the quickest time. In this way the breeder may be reckoned as an 'artist'.

The plant is only one factor and a 'crop' a number of factors. The factors must be considered as a whole and the machinery must not be thrown out of gear. Hence the study must be all-round and should be a study of the plant as a living whole. Plant breeding as a science is the synthesis of many branches of study such as biology, taxonomy, physiology and cytology.

A few varieties introduced from other countries have become popular e. g., the Great Scot potato, the Uganda cotton, the saline-resistant strain of rice S. R. 26-B etc. By following the time-honoured pure line selection, it has been possible to produce some very good strains in the important crops of this State.

The third method of producing new varieties is by hybridisation. In all hybridisation work certain fundamental factors are involved, e. g., the right choice of parents, the type of crossing that has to be adopted e. g., whether it is the single, multiple or cyclic crosses that will be useful, at what stage back-crossing is to be done, all have to be decided appropriate to the crop and the specific character one is trying to improve.

Plant exploration: In order to carry out a hybridisation programme, it is necessary to have as wide a collection of as many races of the crops plant as are available from the different regions of the world where these are grown. The explorations by the Russian botanists headed by Vavilov have brought forth results of not only high scienctific interest but of immense practical value to plant breeders. From the 191 botanical varieties in wheat known to the best workers on wheat, (Percival) Soviet expeditions have increased the total to 800. Formerly there was known but one Linnæan species of potato (S. tuberosum) but during the past decade the explorers aided by the cytologists, physiologists, and botanists have discovered 18 new species of cultivated potatoes and a dozen species of wild potatoes. According to Vavilov the longer the crop plant had been established in a given area, the larger the number of allied species that are found there; in addition to these it also abounds in a wealth of forms with rare and dominant genes. He also enunciated what may be called the law of "Homologous Variation". Now we know in which regions of the world we must look for definite genotypes; we know where productive large-seeded forms are located; where to look for plants with solid straw, varieties resistant to definite fungus diseases and so on.

The collection of such breeding material in this country must be considered very fragmentary compared to the progress achieved in foreign lands. The collection in the State are limited to what are easily available, and it is high time more serious efforts are made in this direction.

Interspecific hybridisation—Genes constitute the building blocks of the breeder; the larger and more varied is the store of this material the greater are the chances of creating new forms, While agronomically useful genes associated, say with yield, quality. etc., are available in the cultivated crops, those which constitute special traits such as winter hardiness, resistance to pests and diseases etc., are usually met with only in their wild ancestors, which may belong to the same species or to allied species. It is through the use of such wild relatives that the breeder can build up varieties with new characters and no amount of intensive work with the existing cultivated types will give us the desired results.

But crossing two species is something like breaking the parts of two motor cars and reassembling them into a new car. One of the greatest difficulties in the use of species crosses has been the sterility in the succeeding generations. Besides the sterility question, the desired combinations in the F_2 generations following an interspecific cross may not be realised due to powerful restrictions to character recombination such as gametic and zygotic elimination, pleiotropy and linkage.

Even in crosses between parents with the same chromosome number, there are great difficulties as in the *Indica* and *Japonica* groups of rice. These might have been separated by long centuries of independent evolution during which the genetic constitution of each may have become so transformed that the two retain very little in common, beyond the chromosome number. Although these races cross readily, the hybrids between them are in a state of genic unbalance and the desired combinations between them are difficult to obtain and also unsatisfactory.

The main difficulty in most of these crosses is the large number of factors in which the parents differ and the difficulty of of getting the desired combination. This can be overcome by growing

(1) Suitable large populations to select from, and

(2) By repeated back-crossing of the hybrids with the parent which it is proposed to improve.

The sterility in the hybrid which is also very common may be got over by doubling the chromosomes to produce a stable amphidiploid.

Hybrid vigour: Connected with the question of quantitative characters is the phenomenon of hybrid vigour or heterosis that results when two parents are crossed. The matter of vigour may be

in respect of size, resistance to pests and diseases, greater fertility, etc. The study of hybrid vigour appears necessary in all plant breeding work to differentiate effects of Mendelian dominance from effects due to heterosis. Different workers advance different causes for this phenomenon. But whatever the explanation, hybrid vigour has been exploited by plant breeders from a very long time. Even in plants produced from seed, this phenomenon is made use of in increasing the yields as in maize, brinjal, tomato etc,, by growing the first generation hybrids on a commercial scale, Recently in Madras a scheme for the production of 'hybrid cumbu' is in operation.

There is a definite 'combining ability' between certain inbred lines that gives the maximum vigour, and this 'combining ability' has been found to be a genetic character. Among vegetables it is found that cucumber, and ladies finger show a good deal of hybrid vigour. Root crops such as sweet potato and tapioca offer possibilities for utilising hybrid vigour and work on them has been started in Madras.

Polyploidy: The enormous potentialities of utilising polyploidy for producing new types of plants superior to the existing ones, has stimulated, since the past two decades, research on polyploidy, its mode of occurrence in nature and its production by artificial means The occurrence of polyploids is now known to be a common feature in the experimental cultures of several workers.

It must not, however, be forgotten that in all breeding work there is an element of a gamble. Not all polyploids may be desirable. This is a vast field in which many workers are needed, and patient work, for a long time.

In foreign counties several methods of inducing polyploids are in vogue – alternating heat and cold, X-raying germinating seeds, use of chemicals, such colchicine, acenaphthene etc., But the most successful one has been found to be the colchicine treatment on seeds, seedlings, growing tips of twigs, or buds. Successful results have been secured by the following methods; aqueous solutions, or in weak alcohol, suitable emulsions and lanolin paste, agar solution, glycerine and water and glycerine and alcohol. The range of concentration varied from 0.0006 per cent to 1%, and the duration also varied from mere wetting to 24 hours.

In this various experiments are being made to double chromosomes by the colchicine treatment and it hoped these would prove successful in due course.

Cytogenetics: A knolewdge of the chromosome theory of heredity is essential to plant breaders. The crops are the end result of the interaction of genes carried in chromosomes. The student of plant breeding will be able to understand these phenomena and

derive logical explanations for the results obtained in the course of his breading work only where a knowledge of the chromosome mechanism for the particular plant under study is available.

Breeding for special characters: It has been shown by recent researches that the laws of inheritance of characters, are equally valid for the less obvious physiological and economical characteristics as well. This opened up a new line of work for the plant breeder, who has not only improved the yielding capacity of the cultivated varieties, but also characters like disease-resistance, winter-hardiness, drought-resistance, non-shattering of grain etc., Later on interest also increased in improving the 'quality' of crops e.g., the gluten of the wheat grain, fats in oilseeds, protein in fodder, ginning percentage and spinning value in cotton and so on.

But it has been made clear during the past four decades of genetical studies, that these economic characters are compound characters made up of several components going together and a proper balance must be maintained between them during the breeding processes. In certain crosses, the effects of minor and modifying characters cannot always be distinguished from the effects of environment. Most of the characters of economic importance cannot be readily grouped into classes as the genes may act in a cumulative manner.

But thanks to the pioneer work of Fisher, Yates, Mather and other biometricians, more definite knowledge of the extent to which these disturbing factors could be evaluated, is now being accumulated in the shape of replicated progeny-row trials from the early stages of hybridisation work, and certain statistics which are useful in the study of these characters.

Crop breeders with the collaboration of other specialists have taken up the study of some of the special problems in this State. We have evolved blast-resistant rice strains, black-arm resistant cotton, and rust-resistant tenai. Certain strains of rice are more drought-resistant than others and also higher yielding. Certain cotton types, while yielding as much as the local types possess also a higher ginning percentage and longer staple. It must, however be admitted that a very great deal is yet to be done by intensifying the work. Improved types for vast stretches of marginal lands, saline areas and habitually flooded areas have yet to be evolved. Breeding is a continuous process and with the advances of knowledge in various associated sciences the plant breeder has a wide field for work and helping the country.

Maximisation of Production by the Cultivation of Hybrid Strains with Special Reference to Cumbu (Pearl Millet)

By

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(Millets Breeding Station)

Introduction: The phenomenon of hybrid vigour has engaged the attention of plant breeders and geneticists from very early times. In recent years, the utilisation of hybrid vigour or heterosis, for improvement of crop yields has brought forth very valuable results. In naturally cross-pollinated crops, continued inbreeding results in loss of vigour of the progeny and consequent reduction in yields. Hybridisation between the inbred types, in cross-pollinated crops, is usually accompanied by greater vigour in the resulting progeny leading to phenomenal increases in yield. This factor, coupled with the ease of hybridisation on a large scale, paved the way for the exploitation of hybrid vigour as a method of maximisation of production in these crops. The results achieved in one of them, maize, have clearly demonstrated the potentialities of this method and have revolutionised corn production in all the corn-growing countries of the world. The remarkable achievements attained in corn production, through the introduction of hybrid strains, have stimulated investigations on similar lines in other cross-pollinated crops. Among Millets, *Cumbu* has responded remarkably well and the results obtained from preliminary studies, at the Millet Breeding Station, Coimbatore, are briefly presented in this paper.

Causes of Hybrid Vigour: Different interpretations of the causes giving rise to the phenomenon of hybrid vigour have been given by various workers in this field. Keeble and Pellew (3) explained the increased vigour of a cross between two varieties of peas, as due to the dominance of the thick stem of one parent and the long internode of the other. This was not found generally applicable, as other cases of manifestation could not be explained on an equally simple basis. Jones in 1917 (1) developed the hypothesis of 'Dominance of Linked Genes" giving hybrid vigour a factorial interpretation. This has been accepted by most plant breeders and geneticists. He maintained that numerous genes were responsible for the expression of quantitative characters and that some of the genes responsible for yield were at least partially dominant. The increased vigour of the hybrid, according to him, was due to the action of different dominant growth factors contributed by each parent. Jones (2) has recently shown that apparently degenerative changes in six mutations in homozygous inbred lines of maize produced a notable degree of heterosis, when these mutants were crossed with the original inbred parents. On these findings, he interprets heterosis as an accumulative effect of favourable heredity from both parents.

The Floral Mechanism in the Pearl Millet: Among the millets, *Cumbu* is the most highly cross-fertilised crop. Unlike most of the grasses, the stigmas of this millet mature earlier than the anthers, resulting in protogyny and cross-pollination. The inflorescence is a terminal compound spike with a variable number of rachillae, spirally arranged round a central axis. The rachillae which vary in length, bear at their apex a whorl of bristles enclosing two spikelets, each of which consists of a male and a hermaphrodite flower. Flowering commences at the

tip of the panicles by the protrusion of the stigmatic branches of the hermaphrodite flowers. This process is continued in the lower spikelets, and proceeds downward to the base taking about two to three days for completion. This protrusion of the anthers and the dehiscence of pollen commence only after the stigmatic emergence with the result that, when the top anthers begin to shed pollen, the emergence of stigmas would be almost complete in the whole panicle The anthers in the hermaphrodite flowers of the panicle, situated slightly below the tip emerge and shed their pollen first. The protrusion of anthers further proceeds upwards and downwards along the panicle, till the tip and base are reached. At this stage, another flush of anthers takes place from the unisexual flowers of the spikelets which supplements the pollen supply for fertilisation. The process of anthesis is completed in about 4 to 5 days. The interval between the emergence of the stigmas and the commencement of anther dehiscence is two to three days, and as the stigmas are quite receptive and exposed to wind, that may carry foreign pollen, natural cross-pollination takes place to a great extent. This has been already recorded in a previous paper (13). It was found that natural crossing in *Cumbu* varied from 27 to 78%. Being so highly cross-pollinated, it is to be expected that natural populations of this crop are mixtures of heterozygous individuals. Continued selection may help to isolate some true breeding and fairly vigorous types. But it is beset with difficulties. It was hence considered desirable to investigate the possibilities of taking advantage of its natural cross-pollination for utilising hybrid vigour for increasing its yield.

Preliminary Investigations on the Production of Hybrid Strains in Pearl Millet: Preliminary studies for the evolution of hybrid strains in *Cumbu* were started at the Millet Breeding Station, Coimbatore, in 1943. In the first year, 15 crosses were made between eight different types of *Cumbu* and they were compared with their parents, in row yield trial plots in the following season. It was observed that in three crosses, the hybrids yielded more grain than both of their parents, the increases ranging from 16 to 163%, and in five others the hybrids yielded higher than one of the parents only. Thirty-eight crosses were made in 1944, and 23 of these yielded more grain than both of their parents. Forty-eight crosses were made in 1946 and tested in the following season, when 11 of them yielded more grain than both of the parents. These results clearly indicated that there was great possibility of obtaining increased yields in *Cumbu* through the introduction of hybrid strains.

Hence detailed work on the evolution of hybrid strains of *Cumbu* was taken up under a scheme sanctioned by the Madras Government from 20th March 1946 to 19th March, 1950. Hundreds of fresh samples of seeds of *Cumbu* were collected and studied, and promising selections isolated from them. These were inbred, crossed, and the hybrids studied to test their yielding capacity and other economic characters. More than 880 crosses were made in the period up to 1950, and 743 of these were tested for row yield trial in small plots and preliminary yield trial in larger plots. Only 25 of these hybrids were significantly superior to both of their parents and the standard, while 39 were superior to both of their parents, and 102 gave higher yields than one or the other of their parents, or standard. The promising hybrids in such tests were multiplied on a large scale by growing the parents side by side in two row plots and hand pollinating sufficient number of female plants to get enough seed for conducting yield trials in larger plots for comparison with the parents and standard. The best of these hybrids were given out for district trials. The primary object of the investigation being the economic utilisation of hybrid vigour, stress was laid on the grain yield of the hybrids as compared to that of the parents and standard. To provide further evidence of the manifestation of this phenomenon, the fresh weight of straw of the hybrids was also noted. The majority of the hybrids which gave significant increases in yield over the standard resulted from crosses between types which were widely separated in their origin. The types from Sind or the Punjab figured as valuable parents. Similarly maximum increases in yield were almost met with in these hybrids, thereby establishing the superior combining ability of widely separated types. These results indicated that in the Pearl Millet, as in the case of most of the naturally pollinated crops, heterosis is manifested in the

progeny, when different types are hybridised. Heterosis is expressed in varying degrees, but the greater the diversity of origin of the parents, the greater is its manifestation. Certain of the types included in the present studies show a high degree of combining ability in crosses with others, and the increases in yield of grain are so high, as to deserve special attention for economic exploitation. Among the hybrids, so far produced, X. 1 and X. 2, which were isolated earlier, were subjected to systematic trials from 1946 onwards In the first year, the hybrid seeds were produced by sowing their parents in alternate lines, the male parents being sown three days earlier than the female parents. The female lines, bearing the hybrid seeds, were harvested separately. These seeds were put in yield trial plots in 1948. Data showed that the hybrids were significantly superior to the standard and their female parents. In subsequent trials, the hybrid seeds were produced by artificial pollination, and tested in comparative yield trial plots.

Taking all the yield tests, both the hybrids were significantly superior to their parents, and also the standard strain Co. 1, which by itself is a high yielder, and hence both the hybrids were advanced to the next stage of work viz., trials in the fields of the cultivators.

Trial of Hybrids in the Districts: To test the suitability of the best of these hybrids in the different districts of the State, extensive trials in cultivators' fields are necessary.

The hybrids – X. 1 and X. 2 were sent to eight different taluks in the districts of Tiruchirapalli, Coimbatore, and Tirunelveli in 1948 for conducting trials in large sized observation plots along with the local variety of *Cumbu* for comparison. In Musiri taluk in Tiruchirapalli the trials were conducted at two centres and X 1 gave an increased yield of 61% and X. 2 gave 60% over the local type. In the trials conducted in Perambalur taluk, 14% increased yield over the local in the case of X. 1 and 74% in the case of X. 2 were obtained, and the cultivators were very much impressed by the performance of X. 2. The hybrids were not found suitable for Tirunelveli district in this trial. In 1949, both the hybrids were sent out for extensive trials in 66 taluks, distributed in 17 districts viz., South Vizagapatam, West Godavari, Guntur, Bellary, Nellore, Kurnool, Cuddapah, Anantapur, Chittoor, North Arcot, Salem, South Arcot, Tiruchirapalli, Madhurai, Ramnad, Tirunelveli and Coimbatore. Reports received so far on the trials conducted in the districts indicate that both the hybrids are superior to the local types in most of the southern districts of the State. Results showing the superiority of the hybrids X. 1 and X. 2 over the local types were received from the taluks of Musiri, Perambalur and Karur in Tiruchirapalli District, Arupukottai and Mudukulathur in Ramnad District, Dindigul in Madhurai District, Attur, Namakkal, Tiruchengode and Omalur in Salem District, Kallakurichi in South Arcot District, Coimbatore in Coimbatore District, Koilpatti in Tirunelveli District, Vavalpad in Chittoor District and also Harpanahalle and the Agricultural Research Station, Siruguppa in Bellary district. Increases in yield over the local varieties ranging from 12 to 220% in the case of X. 1, and from 11 to 260% in the case of X 2 have been reported from the places mentioned above. Reports of trials conducted in South Vizagapatam, Cuddapah and Nellore show that these hybrids are not suitable for these tracts. The districts and taluks where the hybrids have been found suitable and increases in yield over the local types are given in the following tabular statement.

Districts and Taluks, where the hybrids—X. 1 and X. 2 are found suitable (1949–1950).

District	Name of taluk	Centre of trial	Yield expressed as percentage of local		
			X. 1.	X.2.	Local.
Salem	Namakkal		130	139	100
,,	Trichengode		...	113	100
,,	Attur	Ammanpalayam	168	136	100
,,	Omalur	Arthukavanur	120	...	100

District	Name of taluk	Centre of trial	Yield expressed as percentage of local		
			X. 1.	X.2.	Local
Coimbatore	Coimbatore	Ondiputhur	156	145	100
Madhurai	Dindigul	Thadicombu	168	...	100
Ramnad	Arupukottai	Kanjanaikenpatti	172	119	100
,,	,,	Ramanujapuram	122	111	100
,,	Sattur	Vellayapuram	135	144	100
,,	,,	Muthulingapuram	124	130	100
,,	Mudukulathur		145	153	100
Tiruchirapalli	Musiri	Chithalarai	188	161	100
,,	,,	Valavandi	161	163	100
,,	Perambalur	Perambalur	114	174	100
,,	Karur	Rangapalayam	181	171	100
Tirunelveli	Koilpatti		129	132	100
South Arcot	Kallakurichi	Kurur	220	260	100
Bellary	Harpanahalli		132	121	100
,,	,,		128	119	100
,,	Agricultural Research Station, Siruguppa		112	115	100
Chittoor	Vayalpad		...	118	100
		Average	148%	144%.	

From the above statement, it will be seen that these two hydrids are capable of giving much higher yields than the local types in most of the southern districts of this State. As already indicated above, there are tracts where these hybrids have not been found suitable. Regional work has been take up for such tracts, and hybrids made from zonal collections are awaiting trials in such tracts. Apart from the two established hybrids, 32 more are in various stages of trial and they too offer a wealth of material for final choice after comparative yield studies. Along with the work on these hybrids, systematic studies and inbreeding are also in progress for the isolation of standardised types for hybridisation, so that hybrids with specific combinations of characters suitable for different tracts and sub-tracts can be evolved.

Discussion: In an unselect sample or variety of a normally cross-pollinated crop, many of the genes responsible for vigour may occur in a heterozygous and randomly disributed condition. Continued inbreeding will result in the production of a number of separate strains, with a progressive increase in the number of such factors in a homogyous condition. This inbreeding and selection leads to a separation of factors on whose combined presence depends the original vigour, and it also eliminates rapidly those deleterious recessives which produce such unwanted characters as dwarfness, sterility, chlorophyll deficiencies etc, Thus as a result of inbreeding, a large number of strains are obtained which, though poor in yield, are free from the grosser defects and are uniform in their genetic constitution. If two such strains are intercrossed, a recombination of

factors occurs, giving rise to a hybrid which is more vigorous than the parents. In order that this vigour is obtained uniformly and to the maximum extent, it is necessary that the combining ability of the parents should be tested in various combinations and inbreeding should also be carried out simultaneously to attain a high degree of homozygosity. It is observed that vigorous inbred parents do not always give proportionately vigorous hybrids, showing thereby that no standards can be fixed for selection of characters responsible for hybrid vigour The only method to judge the merits of a type is to test it by crossing with several others. The stage of inbreeding, when the parents are fit to be tested by crossing, cannot also be definitely determined so as to attain maximum homozygosity of inbred lines, which will assure increased vigour in the hybrids. In crops where hybrid vigour is utilised on a commercial scale for increased production crossing is done at a very early stage. Top crosses, wherein commercial varieties are crossed with inbred lines, are considered of much value in testing the efficiency of parents. Combining ability being established as an inherited character, it may be expected that the performance of hybrids between plants of unselected bulks can be taken as the criterion for selection of promising types. As indicated by the results presented above, heterosis on an economically appreciable scale, is expressed in the Pearl Millet and it is worthy of commercial exploitation. The combining ability of different types and the varying degrees to which it is expressed in particular crosses is clearly brought about by the present studies By inbreeding the types, which have shown great combining ability, it is expected that inbred lines with desirable characters can be crossed to secure the required type of hybrids. The methods of large-scale production of hybrid seeds for distribution is a problem demanding particular attention in this crop, due to the peculiar floral mechanism of the plant. Unlike in maize, where detasselling of female parent rows will completely eliminate the possibility of self-pollination, absolute prevention of the same, on a field scale, cannot be achieved in *Cumbu*. due to the hermaphroditic nature of the flowers, and the consequent self-pollination of the lower flowers of the spike by the pollen of the top flowers. Perhaps induction of male sterility in female rows may assure complete cross pollination. But attempts so far made to induce male sterility have not been successful.

The preliminary studies made so far at the Millets Station, have indicated the high degree of cross-pollination (70 to 80%) that takes place in this crop; and that itself serves as an easy method for the production of hybrid seeds. Cross-pollination to the extent indicated above could be obtained by sowing the two parents in adjacent rows and also by mixing the seeds of the parents. As this method is both easy and cheap and as it guarantees a high degree of cross-pollination resulting in increased yield. it is being adopted for large scale production.

Conclusion: The evolution of hybrid strains in *Cumbu* is more or less a new line of plant improvement work, This is on the model of the production of hybrid corn, which is an established agro-industry in the United States of America and other corn-growing countries of the world. In the United States of America, it took more than 25 years of research work to evolve the first commercial hybrid. But in India, it has been possible to evolve two high yielding hybrids in the course of four years of work at the Millets Breeding Station, Coimbatore. These two hybrids X. 1 and X. 2 have established their suitability over a very large area in nine district trials is 48% over the local types in the case of X. 1 and 44% in the of X. 2. Taking the average increased yield over the local types to be 45%, it may be estimated that an annual extra yield of more than 80,000 tons of *Cumbu*, valued over Rs. 170 lakhs, can be obtained from these

strains, if half of the entire area under cumbu in the nine districts is brought under the hybrid strains. Six more hybrids have passed the experimental stage and await trials in the districts. When the trials are completed, these too will be available for spread according to the special needs of the different tracts in this State.

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Pretreatment - A New Aid for Improving Crop Yields

By

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It is the object of this paper to just outline a few of the results obtained in the direction of improving yields by a new method—that of supplying nutrient elements to plants before they are sown.

It is course a truism to say that good crops are assured by good manuring. in the same way as good food makes for sturdy men and women. What is not so widely known is the fact that for plants too, a little help in the early stages, goes a long way in improving the subsequent growth and their ultimate yields in the same manner as a liberal supply of milk and milk products to children helps in laying the foundation for a strong and healthy manhood. The basic principle underlying the idea of pretreating seeds with nutrient salts is to introduce into the seed enough of the major nutrients like phosphorus and potassium in a readily available form, sufficient to carry the young plant through its early stages, before its root system is sufficiently developed to make full use of the available supplies of these nutrients in the soil.

In the present day context of all-round scarcity, for everything from a match box to a motor car, it is imperative to use what we do have, to the best advantage and make a little go a long way. The question of supplying fertilizers to crops is no exception to this rule

and in recent years, attention is being directed towards a more efficient use of fertilizers. by means of split doses, fertilizer placement, at optimum depths, by seed coating etc. Among the various methods that have been tried with the object of making available a larger quantity of nutrient elements to growing plants the one suggested by the English workers, Roach and Roberts in 1948 deserves a special mention. These workers investigated the possibilities of this method, both as a means of supplying major plant food elements like phosphorus and potassium and as a means of correcting trace element deficiencies. They found in the case of oats, that by soaking the seed in about one-third of its weight of a solution of tri-basic potassium phosphate and sowing the treated seed in a phosphate deficient soil, the yield could be improved from 17 bushels (820 lb.) of grain to 25 bushels (1,050 lb.) per acre, an increase of nearly 47 per cent. The straw yields too, showed a corresponding increase. Similar large increases in yield were also observed in the case of other cereals, like wheat and barley, although the optimum concentrations of the soaking liquid were different for these grains. The phosphate imbibed by the seeds was deposited mainly on the husk, and was liable to get easily washed off in running water.

This method as would be realised, has a number of very marked advantages, if only it could be substantiated on large-scale field trials for our major food crops. It is an easy and convenient method, it is simple and does not call for any elaborate equipment, it is comparatively cheap and can be adapted for a variety of crops and various types of nutrient solutions and as such the method can be regarded as having very great potential practical importance as an agronomic method.

Preliminary studies were accordingly initiated at Coimbatore, to see how far the growth and yields of some of our Indian crops could be improved by the use of this presoaking technique. The general method was to soak a known weight of seed in one-third of its weight of a solution of the appropriate salt, the quantity of the solution being such as to get all absorbed by the seed in the course of 24 hours. The soaked seed was then air-dried by spreading it thin in a wide tray, with occasional turnings to ensure uniform drying. A variety of nutrient salts were tried in various concentrations on paddy, ragi, groundnut, bengalgram, blackgram and cowpea. Except in two cases where field trials were carried out, the results below are those obtained from pot culture studies.

In the case of paddy, it was found that by presoaking the seed in a 20 per cent solution of tri-basic potassium phosphate the grain yield was improved by as much as 39 per cent in pot cultures and 13 per cent in field trails. When a lower concentration of 10 per cent of the same salt was used, the increase in grain was 21 per cent in pots and 10 per cent in the field. With ragi soaked

in 20 per cent tribasic potassium phosphate. there was an increase in yield of nearly 60 per cent in grain and 40 per cent in straw. In the case of pulse crops the most useful solutions, as well as their optimum strengths were found to be quite different from those found best for paddy and ragi. For instance, in groundnut the yield was improved best, only by mono-potassium phosphate, used at a concentration not exceeding 2 to 5 per cent. Higher strengths inhibit seed germination. This is in line with the observation made on wheat by Roach and Roberts, where the growth was adversely affected by concentrations of more than 5 per cent, of the soaking liquid whereas barley and oats could tolerate up to 30 per cent. For bengalgram and cowpea a 20 per cent solution of calcium phosphate was found to be the best and gave the highest increase in yields in the preliminary trials. It must also be mentioned that for blackgram, none of the solutions that were beneficial to other crops, were found to be helpful, in increasing either growth or the yield of pods.

In the case of cotton, some striking results have been reported from Indore, as a result of presoaking seeds in nutrient salt solutions. For this crop ammonium sulphate and mono-potassium phosphate were found the best two salts among all those tried and these gave an increase in kapas yield of 157.9% and 126% respectively, as compared to the controls.

It would be clear from these results that there are undoubted possibilities in this new technique of presoaking seeds before sowing them and giving them a better start in the early stages of growth. It is also clear from the studies carried out so far, that for each crop there seems to be a particular concentration of a specific salt, which is the most helpful in improving growth.

As a variant of this technique, we may cite the use of growth promoting chemicals. These growth-promoting chemicals or growth hormones as they are termed, have been found to have very far-reaching and varied effects on plant growth and development, even in very minute doses, more or less on the same lines as vitamins have in human and animal nutrition. A preliminary trial conducted at the Nanjanad Research Station on potatoes, indicated that the yields could be improved by nearly 33 per cent. by soaking the tubers before sowing, in suitable dilutions of these growth-promoting chemicals, such as indole-acetic acid and indole-butyric acid.

Yet another variant of this pre-treatment technique may also be cited on this occasion and that is the process called vernalisation. This process consists in essence, in subjecting soaked seeds or young seedlings to certain modifications of light. moisture and temperature. It was first described by the Russian biologist Lysenko and the term vernalisation itself is one that was coined by the Russians, when they attempted to convert their long duration winter wheats into spring

wheats of a shorter duration. The potentialities of this method too, in regard to shortening the duration of rice under South Indian conditions, without diminution of yield, have been studied at Coimbatore for about three years. A fairly extensive series of experiments have been carried out in the field as well as in pot cultures and it was found that there was a distinct positive response in the yield of certain varieties of paddy, when subjected to vernalisation. The increase in yield was found to range from 14 to 38 per cent in the case of grain and from 7 to 34 per cent in straw.

The few examples that are given above would serve to show, that the method of pre-treatment is one that holds out a distinct promise of becoming one of the most helpful methods towards maximisation of crop production and as such deserves to be explored to the fullest extent that is possible by us.

Pre - Sowing Treatment for Seeds of some Cultivated Plants

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Seeds of many cultivated plants do not germinate easily. Dormancy and impermeability of seed coat act as the main barriers in their germination. There are several methods of seed treatment for improving seed germination. But due to the complex nature of these treatments the agriculturist is unable to exploit them under our conditions, but is compelled to adopt a heavy seed rate to make up for the low seed germination. This entails a heavy loss of seed and cumulatively the waste of seed runs to several lakhs of rupees.

Trials at the Agricultural College, Bapatla with various methods of seed treatment, have shown that heat through water is the simplest agency for overcoming impermeability of seed, coats and secure increased germination. The response given by some cultivated plants, the method of treatment needed for each and the resultant advantages are briefly given below.

Wild Indigo *(Tephrosia purpurea) Vempali* — Telugu; *Kolingi* — Tamil.— This is a green manure crop grown extensively in South India and the annual consumption of seed is estimated at 5,000 tons. Pre-treatment by steeping in water at 90° C for five minutes induces over 60 per cent germination in a week's time, as against 15 to 30 per cent secured with the seeds normally in a month's time. The pre-sowing treatment is simple, economical and is far better than the existing method of pounding the seeds with sand.

A field contains only 40 per cent of good-sized plants and the rest are undersized and stunted, developed from seeds germinated long after sowing. Germination in one flush in this crop enables us to secure a uniform crop and the yield of green manure is also increased considerably. The seed rate can be reduced and the yield of green material can be doubled by simple pre-treatment of seed before sowing.

2. **Sunnhemp.** *(Crotolaria juncea) Janumu* — Telugu; — *Sanal,* — Tamil — One of the most extensively grown fodder cum green manure crops of South India is sunnhemp. Over 10,000 tons of seed are utilised annually. Normally 80 to 90 per cent of the seeds germinate and the seeds are generally soaked in water overnight before broadcasting. This enables the seeds to germinate quickly and utilise the moisture remaining after harvest of paddy in wetlands. By steeping the seeds in water at 70°C for five minutes the pace of germination is increased and the entire lots of seeds, excepting dead, decayed and immature ones, germinate within 24 hours. A uniform crop is ensured with 5 to 10 per cent increase in germination. Such an increase in germination amounts to a proportionate increase in the yield of green manure for paddy, and this is by no means inconsiderable.

3. **Leucaena glauca.** *Nagarikesari,* Telugu— This is a quick-growing shrub useful for fuel and green manure purposes. The hard, shining seeds when soaked in water at 80°C for five minutes give 80 per cent germination in a week's time as against about 25 per cent secured normally. Large-scale field sowings have demonstrated the efficacy of this treatment.

4. **Delonix elata** *Vadanarayan* — Tamil: — *Delonix regia* Gulmohr — These are avenue trees found all over the country. These seed profusely and the seeds are hard and metallic and do not easily germinate. Owing to this drawback, these are propagated mostly by cuttings Steeping these seeds in water at 85 and 90°C respectively induces 50 to 75 per cent germination in a fortnight. Seedlings can be propagated in thousands and supplied as a part of the tree-planting drive initiated recently. The existing method of propagation by cuttings can be dispensed with, as it is uneconomic.

5. **Wood apple.** *(Feronia elephantum) Velaga* — Telugu: *Vilam.* — Tamil — A perennial, long-lived sacred fruit-tree of India is wood apple. The fruit is highly nutritious, and also medicinal. The seeds can be extracted by washing the pulp in water on a sieve ordinarily used in houses and mixed with wood ash and kept free from insect and fungus attack The seeds are hard and do not germinate easily. Soaking in water at 60 C for five minutes ensures cent per cent germination in a month's time. Large-scale nurseries can be raised utilising this method. One plant in each backyard will last for decades and will ensure an unfailing supply of fruits regularly every year even with hardly any care or attention.

6. **Phyllanthus emblica** *Indian Gooseberry* — Telugu; *Usiri* — *Nelli* — Indian gooseberry is reputed to be the richest source of vitamin C and is used for a variety of purposes. The seeds are easily extracted by sun drying the fruits. On six weeks storage after extraction, treatment with water at 80°C for five minutes ensures 80 per cent germination in about 10 days against a meagre percentage obtained normally.

The seeds from one plant alone will be sufficient for planting seedlings in the backyards of all houses in a city like Madras.

7. **Prosopis juliflora, Mesquite.** *Seema jiluka* — Telugu — This is an introduced plant eminently suitable for our conditions Except the tender leaves goats do not relish this plant. It is a thorny, quick growing tree ideal for hedges. The pods are sweet, leathery and form a good feed for cattle The extraction of seeds from pods is very laborious and difficult. Treatment of the pods with sulphuric acid diluted in water in the ratio of 1:4 for 24 to 48 hours in an earthern tub, softens the pods and facilitates extraction of seeds on pounding with sand after thorough washing and sun drying. Seeds scarified with sand and soaked in water at 70°C for five minutes give about 75 per cent germination in three days. The acid treatment is not injurious and is economical.

The Horticultural Approach in Maximising Food Production

By

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Introduction : Any agricultural policy for maximising food production should draw its inspiration, not from the accidents of temporary food shortages but from fundamental concepts of human nutrition. In the shaping of a food plan for the Indian Union we should distinguish two aspects that have gained clear recognition at the hands of nutrition experts. First, of course, is the need for providing the requisite amount of calories which supply the needed energy for people of different ages and in different avocations in life. Second is the introduction into the diet of an adequate quantity of protective foods which are indispensable to keep the human body free of illnesses traced to ill-balanced food. As Sir John Orr put it in that documentary film 'The World of Plenty' "It is not enough to eat more food–it is the kind of food that matters most" Governments today are assuming greater and greater responsibilities for the regulation of agricultural production, and the shape and hue which agricultural industry takes under such direction should make the fullest use of what scientific facts have to offer. Into a pattern of that kind, therefore, a purely unregulated agriculture weighted wholly in favour of calorie-yielding food crops will no longer fit. Modern agricultural policy in the Indian Union should not merely be a palliative for our food shortage, with its sole interest to alleviate hunger at the expense of health. On the other hand, it should be attuned to the national requirement of an improved dietary with a readjustment to concepts of food in relation to health.

The Place of Horticulture in Food Production: This paper is a plea for putting horticulture firmly on the map of agriculture in India, both as a measure of maximising food production in the country and as a means of supplying the essential protective substances in the most abundant and acceptable forms. In the role of protective foods, fruits and vegetables suppiy minerals and vitamins and their pectin and cellulose are of proved value in regulatory functions in the human system. On the food front, they play a most important role in bridging the gap in our food supply. For instance, with an area of nearly 1,40,000 acres under bananas in Madras State, and an estimated annual production of over 11 lakhs of tons of this valuable fruit, we occupy the front rank in the world among the banana producing regions. A deficit of 8 lakhs of tons of rice per annum which faces us today in not therefore a feature that should worry us in this State, if only we supplement our diets with ripe and fresh bananas distributed all over the country in an

equitable and uniform manner. A more liberal use of mangoes, oranges and other seasonal fruits in our diets should also go some way in reducing our sole dependence on rice and wheat, incidentally with considerable benefit to our health,

Notwithstanding the above facts the production of fruits and vegetables is as yet inadequate to provide for a suitably balanced diet in minimum quantity for the 400 million people of India. The production of fruits must be increased by 50 per cent and vegetables by 100 per cent, to meet our requirements adequately. The question of maximising the output of fruits and vegetables as a means of augumenting food production is, therefore, of real urgency in the context of our food shortage.

Planning in Fruit industry: Fruit-growing is essentially a olong-term profession and its success demands a long-term plan. Seldom do we, hswever, see this precept put into actual practice in this country. To most people, etablishment of an orchard is a very simple affair. It begins and ends with clearing the land. digging of pits, planting with plants from the nearest source, and manuring and watering them from time to time. Nothing appears easier. It is this tendency for simplification that has hindered the progress of the fruit industry more than anything else. Instead of orchards adding to our national wealth and increasing the food resources, one sees abundant evidence of bad taste, wrong values and even actual plunder of the land, giving rise to innumerable 'orchard slums' which are the very opposite of what orchards should stand for in a country's life and economy. If, on the other hand, fruit-growing is planned along the lines that scientific research and experience have made possible, the amount of extra wealth and food that would be created can reach a colossal figure. We have in this country the soil, the climate and the men and material needed to make fruit growing in India into an efficient industry. The first step towards this goal is to avoid ill-planned orchards, planting wrong varieties and in wrong sites or regions. Such disastrous results can all be prevented by thoughtful planning on a long-term basis. What we should visualise is the ultimate form that our fruit industry should assume on the food front. Fruit being an industry of national importance, a plan that fosters its development in all parts of the country with due regard to the natural facilities and limitations of each region has to be evolved. Such a plan involves an amount of knowledge and authoritative data which no single person or administration can possess. To pre-arrange and correlate the regional and individual experiences would be the first step towards planning. The need of the hour is to organise a fruit-planning committee on the lines indicated above.

Orchard Maintenance: A vast difference exists between merely growing fruit and the production of fruit on a sound commercial basis. It is a common feature of every market to see varieties of fruit which should have been discarded long ago. A rational development of the fruit industry is only possible when solvency is imposed on fruit culture, absentee orcharding is abolished and and untested irrational methods are substituted by timely technical guidance. The fruit grower must take into account important factors such as soil, climate, variety, root-stock, manuring, spraying and pruning and he must have a definite plan of action covering a period of years. All these were no more than hazy traditions but research is now rapidly arranging them into a rational code and it ill behoves the fruit grower not to take advautage of such an advance.

Product Industries: The importance of the horticultural industry in India's food problem is not exhausted by the direct addition to our protective food supply and to our increased wealth through the utilisation of land by a more profitable method than by

agricultural farming. The establishment of auxiliary industries such as the manufacture of fruit products from surpluses during peak years must also be included among the assets that fruit and vegetable growing offers in the way of famine insurance.

Marketing of Orchard Produce and Economics: The welfare of any industry—primary or secondary—is based on certain fundamental pre-requisites. In the first instance it must be organised, secondly, it must possess the basic knowledge necessary for the efficient production of its product. In the third place, it must know its cost of production. Fourthly it should be capable of estimating in advance the quantity that will be available from year to year. Finally, the problem of marketing has to be faced with a full knowledge of quantities, costs, sales and returns.

In practice, however, the product as well as the price in the fruit market are subjects of perpetual discredit. It is the general experience that extremely poor quality fruits of various kinds are sold to the public at very high prices, the purchaser having no choice in the matter. It is hardly ever realised that one of the main causes for an unsteady and gloomy outlook that faces the fruit growers in the market is the present method of distribution and sale. The level of income in the country does undoubtedly shape the off take to a large extent but there is much that the producers themselves can do in the line. In any appraisal of the economic position of the grove no less than that of the industry as a whole, a long-range view is essential. The economic position has to be strengthened by a sound plan which can be adjusted to suit the changing income level. When the prices were high and the demand for fruit from the Army was steady, few growers thought of the postwar civilian demand. Bulk movement of fruit occarred, to Army areas and the civilian markets suffered from scarcity of fruits and high prices. Regular fruit eaters diminished and consequently. there was a sudden drop in demand and prices in the post-war years. Export markets outside the producing State were ignored and have yet to be recaptured. New markets were never fostered. For ensuring a plan to meet all such eventualities, co-ordinated action is essential. Some organisation such as an Indian Horticultural Council that would possess the authority and bargaining power in dealing with countries, regions and interests is an imperative need. Along with the establishment of such a Council, an organised drive towards increased fruit consumption should from a constant effort. This again can be successful only if there is closer co-operation among growers united in one organisation. The advertising charges and cost of other measures to increase fruit eating can then be spread over all producers in small amounts. Co-operative marketing is yet another desirable outcome of such co-ordinated effort, which would have the object of narrowifig down the price paid by the consumer and that received by the producer. This will also lead to improvement of market facilities and elimination of inefficient retailing methods and ensure that the valuable food which fruit growers produce is distributed to the consumer at prices which even the poorest people can afford to pay.

Storage: According to one estimate nearly 60 percent of fresh fruits deteriorate in the course of their transport from the production centres to the consumption or distribution centres under present conditions in India. One of the primary causes for this spoilage is the rapidity with wich the fruits lose water after harvest rendering them susceptible to various types of decay. Even were such produce destined to reach a cold store eventually, the absence of adequte pre-cooling arrangements or refrigerated transport would expose them to all possible infections of decay and disease-causing organisms before bringing the fruit under cold storage. Refrigerated transport along with grove sanitation, scientific treatment of

fruit at harvest, grading and packing should all be considered as logical corollaries of cold storage, which in itself is one of the potent means of contributing towards maximising food production.

Land Utilisation: Governmental plans towards attainment of self-sufficiency in food take into account a computed deficit of 10 per cent in our requirements of food grains. This is sought to be made up by bringing under the plough cultivable wastes, by providing irrigation to erstwhile dry land areas, by intensive cultivation of existing arable land adopting improved farm practices, and by encouraging the cultivation of quick-growing and heavy yielding subsidiary food crops.

It may be emphasised, that the outlook for fruits and vegetables as calorie producers is brighter because they produce in general terms much more from the land than any cereal crop is known to do. Even if this were not so, a scheme for increased output of fruits and vegetables has other resources at its command for intensive land utilisation.

One of these is the harnessing of marginal lands unsuited for arable farming to the raising of a variety of hardy fruits and vegetables such as the jujube, custard apple, Phyllanthus, tamarind, wood apple, drumsticks, yams, tapioca and the like. Another is the build up of a fruit landscape by a merging of fruit bearing trees into the accessible fringes of forests near and around the villages. A third is the planting of shady fruit trees along the highways and roads to form avenues. A fourth is the intensive intercropping of prebearing orchards with a wide variety of vegetables and bush fruits almost throughout the year. All these are means and modes peculiar to horticulture alone and are of real significance in maximising food production.

Concentration on Intensive Manuring is the only way for Maximisation of Crop Production

By

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India is an agricultural country and nearly 83% of the cultivable area is under food crops, 31.6% under rice, 29% under millets and other cereals and 24·7% under wheat. In spite of these, we are in deficit in food grains and import large quantities from outside. There was of course a reduction in area under food crops – due to the partition of the country. The proportion was unfavourable to us as the Indian Union has to maintain 78% of her original population with only 71·7% of original area under rice and 72% under wheat and hence naturally our problem is one of cultivation with the limited area available.

The drive for increased food production was attempted in two directions, firstly by bringing new areas under food crops, diverting areas under non-food crops to food crops, increasing double crop cultivation and also cultivation during the off-season, and secondly by intensive cultivation, by the use of improved seeds and better manuring.

Our attempts at bringing waste lands into cultivation have not been as great a success, as expected ; as the increased area under food crops were not commensurate with the additional expenditure incurred in reclaiming the lands and bringing them into cultivation. The State was also in deficit in the production of cotton and other commercial crops. Large areas have been brought under cultivation but due to the failure of North-East-monsoon rains for the last three seasons, our attempts in this direction did not come up to our expectations. There was success in the spread of improved paddy and other seeds ; but the good effect of these was marred by the failure of seasons, with untimely planting and harvests. Thus in spite of strenuous activities under the " Grow More Food " campaign our success in increasing food production was not appreciable. As a matter of fact, figures show that the average yield of paddy per acre has not increased to the extent expected, especially in the Tanjore Delta, the granary of South India and the largest district under paddy cultivation in Madras State viz., 13½ lakhs of acres. This would be clear from the figures of crop-cutting experiments conducted in the district for the last five years :—

Year	*Average acre yields in Tanjore district*	
	Kuruvai	*Samba*
1945–'46	1755 lb.	1064 lb.
1946–'47	1401 ,,	1234 ,,
1947–'48	1492 ,,	1495 ,,
1948–'49	1424 ,,	1425 ,,
1949–'50	1260 ,,	1406 ,,

The average yield of paddy for Tanjore district as per the "Season and Crop Reports" is 1750 lb. per acre. In Aduthurai Farm, where judicious manuring is being adopted, the average yield figures for any crop viz., Kuruvai, Samba and Thaladi is more than 3500 lb. with maximum yields of 4800 lb. per acre. These figures show clearly that the ryots in general do not apply sufficient quantities of manures to the fields with the consequence that their paddy yields are very low. It is also found from past experience, that our attempts to give manures only to food crops have not been a complete success and instances have come to our notice of manures intended for food crops being used for other commercial crops. Further, either due to the poverty of the ryots or due to peculiar tenure systems, ryots are not very keen on applying manures to their lands and get increased production. In the Tanjore Delta, where there is assured water supply, the intake of ammonium

sulphate was never more than 2000 to 3000 tons per year for such an extensive area of 13½ lakhs of acres. Similarly even when phosphatic manures were sold at concessional rates the sales were not to our expectations and large quantities of super and granular phosphate were left unsold in various depots during the last season. Again it has been proved that green manuring or green leaf manuring for paddy gives increased yields and in Tanjore Delta where *kolinji* is being grown in more than 2½ lakhs of acres the yield of plots grown with *kolinji* crop puddled in are invariably higher than without green manure. These facts are known to every mirasdar but inspite of these, green manure and application of fertilisers have not come up to our expectations. Hence there is an urgent need for concentrating on green manuring and manuring with fertilisers in the Tanjore Delta and in other districts where there is an assured water supply to ensure a paddy crop when once it is planted. Such tracts in this State are (1) Tanjore Delta (2) Periyar Tract (3) Thambraparni Tract and (4) Krishna, Godavari, add Nellore Deltas. In all these tracts there is copious water supply and yields can be increased by at least 20% by the application of manures (green manure and fertilisers). A ready-made mixture can be advocated to each tract viz., groundnut cake, phosphate, and ammonium sulphate with a basal dressing of green manure or at least some organic manure. The manures should be applied by Government agency through the Agriculture Departmental staff just before planting. Regarding green manuring —for instance in Tanjore Delta, *Kolinji* can be arranged to be sown compulsorily just a week before harvest of paddy crop. A band of maistries with a number of coolies to each may go round the villages and effect the sowings of *Kolinji* seeds in all the fields —taking advantage of 100% subsidy given by the India Government — the cost of the operating staff alone should be met by State Government. Similarly various manures should be stocked in villages just before the season and should be distributed and applied under departmental supervision. The cost of the manure should be collected at the time of collection of *kist* or land assessment. The present district staff should be augmented and the staff from other districts should be deputed to work in tracts where manure is to be applied for temporary periods. The senior students from the two Agricultural Colleges may also be deputed for short periods to attend to this work as was done during the year 1917–'18 in the Tanjore Delta for popularising fish manure. Some may go even further and call in military help for this work. A small unit to each agricultural demonstrator can be provided so that with their help the manure can be easily spread in fields, just in time before planting. If this is done yields can be increased by at least 20%, allowing 5% for pests and unforeseen circumstances. At the first instance the experiment may be tried in the Tanjore Delta during *Kuruvai* and *Samba* season and later extended to other districts where there is assured water supply.

The normal area in the Tanjore district, including double crop paddy is 13,27,800 acres and taking a moderate figure of 200 lb. as increased yields due to manuring (though increased yields up to 500 lb. can be easily expected), the extra production will be nearly 1,18,553 tons in a single year. If the scheme is extended to all the tracts mentioned above, then it is possible to increase production by nearly 4 lakhs of tons in one year and our All-India deficiency in rice can be made up in just two seasons viz., 1950–'51 and 1951–'52.

The above scheme may involve a large expenditure, but we are now spending huge sums of money to get food grains from outside and that amount can be easily spent on the above scheme and self-sufficiency can be attained within the period prescribed by the India Government. Food production is to be treated as a war measure, and hence it is of utmost importance to take up such a revolutionary method to increase food production. Unless this is done, maximisation of production can behardly attained before the dead line fixed by the India Government.

Maximisation of Crop Production through Adequate Irrigation

By

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Provision of irrigation facilities is the most potent single factor in any scheme of increased crop production, especially in a country like ours where the monsoons are often erratic and the rains precarious. No doubt, better seeds, more manure and scientific methods of cultivation do play their parts in increasing crop yields. But without adequate and timely supply of water, these cannot produce effective results. By providing an assured supply of water, crop production may be increased by 100%, for the dry land can be converted into a garden land, the garden land into a wet land and the single crop wet land into a double crop wet land.

Irrigation has been in vogue in India from time immemorial and this country is said to be the original home of irrigation. India leads the world in the field of irrigation even after partition. We have still 47 millions acres of irrigated land. But this area though considerable, represents only 1/5th of the total area under cultivation. Of the total area irrigated in our State, Government canals from river projects served 42%, tanks 36%, wells 16% (including subsidy wells) private canals and other sources 6%.

The following are the sources of water for irrigation purposes.

1. Rivers with their irrigation systems.
2. Tanks and Reservoirs.
3. Wells.

Let us consider the scope of improving these sources so that the maximum area could be brought under irrigation.

Rivers and irrigation system: India is blessed with some perennial rivers, which if fully exploited, could supply water for irrigating our entire area under crops. It has been calculated that only about 6% of the available water in our rivers is now being utilised and the balance of 94% is running waste into the sea, causing great damage to life and property, during floods. We have a large number of irrigation projects on hand awaiting execution. Some of them are under construction. Extensive areas are expected to be benefited by these projects and the food problem solved once for all. But it is a question of finance and time. It is a long-range programme, and therefore our policy must aim at quicker and simpler means of increasing irrigation facilities by restoration of tanks, channels and construction of more wells.

Tanks and reservoirs: Tank irrigation is the oldest and easiest form of irrigation. There are about 33,000 tanks in this State. But many of them, especially those in the Zamin areas, have lost a considerable portion of their storage capacity. Hence the imperative need for repairing and renovating immediately all the tanks to their original capacity, so that the entire area under the ayacut of each tank is assured of adequate water supply. The Government sanctioned in 1949 a scheme for restoring irrigation sources like channels, tanks, wells etc. at an estimated cost of Rs. 10 crores spread over a period of 5 years from 1949-50. It was estimated that this scheme might produce 1½ lakhs tons of food grains. But the progress so far made is not appreciable. Enormous delay is experienced in executing the work. Contractors are not forthcoming to take up the work on the plea that the rates are not attractive. Under such circumstances the ryots of the locality must come forward to undertake the work without considering the remuneration. After all they are the people to be benefited by these works. They must revive the good old system of "*Kudimaramath*" and take the initiative in restoring their tanks. Of course the government must make use of such labour-saving equipments as bull-dozers, excavators etc. so that work is finished expeditiously.

Wells: Well irrigation is the only means of intensifying the cultivation where other irrigation facilities like rivers, reservoirs etc. are not available. But well irrigation has its limitations. The presence of underground water must be correctly located; sufficient water must be found and the water must be free from injurious salts.

The underground water must be fed and recouped by rain water which must be conserved by contour bunding, trenching, basin listing etc. It may be noted that due to the failure of rains for the last three seasons in our State, the underground water supply has dwindled gradually and the wells dried up, affecting crop production seriously.

There were about 7,28,092 wells before the well-subsidy schemes, irrigating over 1¾ million acres. About 45% of the total wells were found in the three districts of North Arcot, Coimbatore and Salem which indicates the intensity of cultivation in these parts. With a view to encourage ryots to dig more wells, the government sanctioned well-subsidy schemes from 1944 onwards by which a subsidy of half the cost of construction was paid, subject to a maximum of Rs. 750/- in rocky areas and Rs. 500/- in ordinary areas for construction of new wells. Up to February 1950, 1,90,458 wells were subsidised at a cost of Rs. 5,41,12,774. The number of wells actually constructed were 1,07,401 irrigating an area of 1,28,418 acres and producing an additional tonnage of 64,560 tons. It may be noted that in spite of such a huge expenditure, the actual area brought under well irrigation is only at the rate of 1 acre per well with an additional production of ½ ton per acre.

The following table gives the details of well-subsidy schemes up to February 1950.

Name of Scheme.	Amount paid.	No. of wells subsidised.	No. of wells completed.	Addl. acreage brought under irrigation.	Addl. tonnage produced.
Old 1944 Scheme.	1,03,212	594	293	271	175
Accelerated Scheme.					
New wells.	1,85,43,990	61,558	50,402	65,776	33,399
Old wells.	47,37,882	30,779	26,995	30,180	15,390
Ceded Dts. Modified : Scheme.					
New wells.	9,50,000	1,960	842	1,290	581
Old wells.	1,47,277	530	321	616	332
New well-subsidy scheme.					
1947—48.	1,63,19,652	46,847	23,243	23,202	11,503
1948—49.	1,67,02,386	29,183	4,932	6,448	3,021
1949—50.	1,12,08,375	19,017	373	635	150
Total:	5,41,12,724	1,90,458	1,07,401	1,28,418	64,560

It may be noted, that the well-subsidy schemes were not quite successful in increasing the acreage under irrigation. In fact a good portion of the subsidy was not utilised for the purpose for which it

was given. Well sinking is a gamble in many respects. Only those ryots who were lucky in striking good underground springs were able to finish their wells at reasonable cost. But many ryots, in spite of spending huge sums like Rs. 2000/- and 3000/- were not able to get springs. Thus they were not only frustrated in their efforts but also incurred ruinous debts as well. To obviate such difficulties, an intensive survey of underground water resources of the State must be made. The Industries Department, it appears have studied this problem with regard to a few districts. But this too, was not very helpful to the ryots. Further there is great demand for boring sets to tap deeper sources of underground water. There are a few sets with the Industries Department which are not easily available to ryots. A large number of these boring sets must be made available to ryots at nominal hire charges. There must be an organisation to guide the ryots who dig wells in locating underground springs, to conduct trial borings and to equip the wells with waterlifts. The art of water-divining is still in its infancy and requires further specialisation so that it may be of definite value to the well-diggers. Availability of cheap hydro-electric power is one of the contributory factors for the development of well irrigation. But unfortunately electric connections are not easily available to ryots for irrigation, even though it is freely available for running cinemas and other frivolous activities. Ryots are asked to give guarantees for power consumption beyond their capacity. Electrical goods are not easily obtainable. Such a state of affairs is not conductive to increased food production. The Government must take early steps to remove such obstacles so that the ryots could make full use of electricity for irrigation purposes.

The Irrigation Commission which examined in 1903, the question of extension of well-irrigation, recommended the following measures:

1. The liberalization of *Takkavi* loans and free grants in special localities;

2. Sharing of risks with the cultivator when there is a failure to find water by allowing a partial remission of money which may have been advanced;

3. Conducting trial borings and sub-soil surveys;

4, Providing tools and boring equipments on hire.

Many of these recommendations have been given effect to, but these is urgent need for further intensification of these measures so that results are achieved quickly.

Now the digging of wells with all its uncertainties is left to the individual ryot. There is no reason why the Government itself should not take the initiative in digging big wells and hand them over to ryots who are prepared to pay 50% of the actual cost of

construction or else run them as State wells, fitted with power lifts and charge water cess for the area irrigated by the wells. As a matter of fact the provision of State irrigation wells is not a new practice. During the reign of Pandia Kings, huge wells with excellent springs were dug in many places to encourage well irrigation. Even now we come across some of those wells, though dilapidated in condition. In U. P. and Bihar, these are State-owned tube wells with a capacity of $1\frac{1}{2}$ cusecs, equivalent to 33,000 gallons of water per hour and each capable of irrigating 400 acres. The cost of each tube well is said to be Rs. 40,000/-. The possibility of digging such tube wells in our State also must be investigated. When large sums of public money are sunk in irrigation projects to benefit ryots in certain areas, it is but proper that the Government should extend such assistance to ryots in other less fortunately placed areas for the development of well-irrigation. No wonder that our Food Minister, Shri K. M. Munshi, attaches great importance to scheme which will increase the supply of water. In his eight-point programme, he pleads for the restoration of tanks and channels, wells and borings and construction of a large number of tube wells.

Economics of Crop Production on Bapatla Sandy Soils

By

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AND

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Any visitor to Bapatla, as he approaches the place in the train would be struck with the view on both sides, of stretches of sandy belts, fallow or covered with crops and dotted with palmyra or cashew-nut trees. There may also be attractive green patches of paddy or tobacco, interspersed with jasmine or vegetables coming to view according to the season. A closer observation will reveal the presence of small ponds or '*doruvus*', wells from which water is lifted in pots for 'irrigating' the adjacent crops. The sands drink up water and hence pot-watering is a continuous process from day to day. A visit to these areas will show that very good crops could be grown out of these poor sandy soils. A study of this type of crop production and its economics has been considered worthwhile and might be interest, particularly to students of agriculture.

Area and nature of soil. These sandy areas are found in the eastern and southern portions of Bapatla taluk and cover an area of about a hundred square miles. The area is fairly level, though in some places it is undulating. The sands are deep and have evidently been formed by the receding sea which is now about five and a half miles from the town of Bapatla. It is said that the temple in the heart of the town was built about 900 years ago by a Chola king and the sea was then washing the doors of the temple. The water table is as high as four to six feet. The water is generally brackish, but here and there fresh water springs are also found. By the accumulation of organic matter and by application of cattle manure and leaf composts the soils under cultivation have been improved in their fertility as seen by the very good stand of crops. A few miles from the shore there runs a narrow strip of low-level land for about 15 miles east to west, where good crops of paddy are raised by means of spring water alone. This is an interesting feature. The springs have been dug in sandy mounds on both sides of the pocket at intervals and they are kept in proper flow by renovating them every season.

The seasonal factor. The tract gets the benefit of both the monsoons. The average annual rainfall is 37·12 inches and the distribution is given below.

Statement showing monthly distribution of rainfall

January	Nil.	Inches	July	4·65	Inches
February	0·36	,,	August	5·52	,,
March	0·80	,,	September	8·21	,,
April	0·19	,,	October	8·76	,,
May	0·81	,,	November	4·73	,,
June	2·01	,,	December	1·08	,,

Total 37·12 inches.

The warm summer temperatures, typical of the Guntur district is somewhat tempered by the sea breeze. The cropping season, though not very well established owing to the variety of crops, is roughly as follows:

May to July—Paddy nurseries.

August to November—Tobacco nurseries.

December to March—Ragi, cow-pea, horsegram.

December to July—Chillies, Brinjal.

July to November—Groundnut.

July to August—planting of casuarina, jasmine etc.

(Cow-pea, horsegram and groundnut grown as rainfed crops)

The cultivators and their holdings. As can be expected from the nature of the cropping conditions the majority are small holders and owner cultivators. Some of them have also taken on lease small areas here and there, depending upon the number of workers in the family. The average size of a holding has to be measured in cents and one cultivator with his family of about two other members can manage only about 30 to 35 cents area in which there may be one or two *doruvus.* Some of the wetland ryots of the adjacent delta may also take up small areas on these sands to grow nurseries of paddy or tobacco which give them a good return. The areas originally belonging to Government have been given out in suitable blocks to the backward classes and these have settled in small areas of their own, living in thatched houses built near by. The members of their families work as casual labourers in the neighbouring wetland areas, particularly during the planting and harvest periods. In fact, most of them being small holders, their income from the crops alone will not be sufficient unless they supplement their income by other means. Hand-watering or pot watering of crops is a strenuous operation even for a strong man, as two big-sized pots are used, using both hands each time. The water is splashed on the plants, the quantity allowed being determined by the nature and age of the crop and the weather conditions.

Economics of production. It is difficult to assess the costs of production of the crops in this area, particularly because family labour is fully utilised and the assessment of values can only be approximate. The biggest item of expenditure will be that due to pot watering but it is not felt as cash expenditure and therefore when the charges of this irrigation are not included in the costs, the margin of profit is very high indeed. The statements given below for the various crops of the tract will give an idea of the cost of production and profits, but the value noted for own and family labour has to be borne in mind if the balance sheet is to be understood in its proper perspective. The costs have been worked out on the basis of one acre and labour by cattle is given as pair work days (PWD) and that by human as man work days (MWD), the labour of two women being considered to be equivalent to one man.

Scope for Grow More Food. By increased doses of organic and artificial manures the yields can be stepped up by 50 to 75 per cent, in the case of ragi and vegetable crops. As very good profits are obtained from the tobacco nursery business, the cultivators will not give up the raising of such nurseries. There are still large areas left fallow, belonging to the cultivators and Government which are available for further extension of areas under food crops. The cultivators have to be encouraged with advances or loans without interest to take up all the available area for growing of ragi, paddy and vegetables. The areas belonging to Government have to be given out on easy terms to the neighbouring ryots or other tenants

or landless labourers with supplies of manures at controlled rates, for growing of food crops. The Forest Department has been in charge of hundreds of acres of this area for the planting of casuarina for fuel purposes. Part of this area, cleared of casuarina or to be newly planted, may be devoted to food crops, by leasing them to ryots on favourable terms. Thus, if action is taken very early on the above lines, it may be estimated that at least about two thousand acres of new area may be brought under ragi, paddy and vegetables in the current season itself. The maximisation of yields in this area centres round the maximum application of manures, artificials and cakes etc., as the sandy soils of this tract respond to manuring very well.

Statements of cost of production and profits: We will not have a proper idea of the labour involved and profits obtained if the costs are worked out on an acre basis as given below, and as is the usual case in studies of costs, but it should be worked out really on these sands on a family unit basis which can be fixed at between 25 and 35 cents area depending upon the crop. In such a case the pot watering and other human labour charges have to be eliminated if we should get the right idea of the actual cash income for the cultivator.

COST OF PRODUCTION

(Crops raised by own and family labour)

Area – one acre. (PWD—Pair work day Rs. 2; MWD—Man work Re. 1.)

1. NURSERIES

No.	Particulars of operation	PADDY *June-July*			TOBACCO *Sept. November*			CASUARINA *July-October*		
		PWD	MWD	Rs.	PWD	MWD	Rs.	PWD	MWD	Rs.
1.	Preparatory Cultivation	3	3	9	3	3	9		25	25
2.	Seeds and sowing		4	150		4	50		4	4
3.	Manures & manuring	1	8	80	1	6	120		4	60
4.	After cultivation		4	4		12	12		8	8
5.	Irrigation (POT watering)		120	120		140	140		360	360
6.	Pest control, spraying etc.					4	29			
7.	Horvesting–(Pul ing seedlings)								4	4
8.	Total Cost			363			360			461
9.	Gross receipts	Seedlings sold to plant 40 acres @ Rs. 12 per acre (average rate) 480			Seedlings sold to plant 60 acrres @ Rs. 15 per acre (average rate) 540			Seedlings sold to plant 200 acres @ Rs. 3 per acre (average rate) 600		
10.	Nett profit			117			900			139

Note.— **Paddy nurseries:** If seed is supplied by the ryot who takes the seedlings, labour charges are paid to the sand cultivator. The seedlings are removed and transported in carts by the purchasers themselves.

Tobacco nurseriea: Seedlings are pulled, packed in gunnies rather loosely and transported by rail by contractors. The price of seedlings vary very much according to the season from Rs. 5 to Rs. 80.

No.	Particulars of operation	RAGI Dec.-March PWD	MWD	RS.	CHILLIES Dec.-July PWD	MWD	RS.	BRINJALS Dec.-June PWD	MWD	RS.	PLANTATION CASUARINA PWD	MWD	RS.
1.	Preparatory cultivation.	4	4	12	3	3	9	3	3	10		3	3
2.	Seeds & sowings		4	16		4	16		8	30		10	15
3.	Manures & Manuring	1	4	20		4	60		4	30			
4.	After cultivation		8	8		4	4		5	5		3	3
5.	Irrigation; Pot-Watering		80	80		150	150		120	120		110	110
6.	Harvesting etc.,	2	12	14		10	10		25	25			
7.	Total Cost			150			249			220			151
8.	Gross receipts	12 bags or 2000 pounds at Rs. 16/bag Rs. 192			3000 lbs. at Rs. 15 per 100 lbs. Rs. 450			100 mds at Rs. 3 per md. Rs. 300			At the end of 6 years fuel worth Rs. 800		
9.	Nett Profit	Rs. 42			Rs. 201			Rs. 80			Rs 650		

Note.— **Brinjals:** Generally we do not find much area under brinjals as a pure crop, as the profit is less than from chillies and other crops since the vegetable is grown largely in the dry areas of Guntur taluk and markets are well supplied and prices not very favourable.

Casuarina: The plantation is ready for cutting 6 years after planting. Cutting and removal done by fuel contractors.

3. FLOWER CROP.

Jasmine: Season of flowering, March to July (5 years' crop)

	MWD	Rs.	Remarks
1. Preparatory Cultivation 2. Seeds and sowings	40	40	Includes planting cuttings of old crop.
3. Manures and manuring	4	60	
4. After-cultivation	20	20	
5. Irrigation; Pot-watering	800	800	
6. Harvesting	60	60	
7. Total cost for 5 years		980	

8. Gross receipts

I	year	50 seers of flowers	
II	,,	200 ,,	,,
III	,,	300 ,,	,,
IV	,,	500 ,,	,,
V	,,	400 ,,	,,
Total		1450 ,,	,,

9. Nett profit— nil. Loss over 5 years Rs. 255.

Note.— The area under jasmine is limited to a few cent only in each holding.

The Role of Plant Protection in Intensive Agriculture

By

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The Place of Plant Protection in Agriculture: Protection from enemies is one of the three fundamental requisites for the existence of any living matter, whether plant or animal on the face of the world. The other two aspects, adequate supply of food and adaptation to environment are equally important and the provision of these three primary biological necessities determine the continued existence and development of all living matter. In agriculture, the aspect of food supply and crop nutrition is studied by the Agricultural Chemist and elaborate manuring schedules in respect of different crops and different tracts have been evolved. The suitablity and adaptability of crops to environment is dealt with by the Agronomist and Crop breeder and improved high yielding strains of various crops suitable to different areas have been evolved. Unfortunately, plant protection has remained a neglected subject in our country and our efforts in this direction have been till lately rudimentary and inadequate. It is not often admitted that all the researches and labours of the Agricultural Chemist, Agronomist, Crop-breeder and other agricultural scientists are set at naught by the incidence of pests or diseases. It is yet to be realised that unless all these three branches of agricultural science are developed co-extensively our efforts at progress and maximisation of agricultural production will be figuratively speaking attempts to keep a three-legged stool with one leg removed or very short in a position of stable equilibrium. In this connection an incident related by an American entomologist who visited Germany about 20 years ago is worth repetition to indicate how other countries view the question of Plant Protection. Germany grew very little corn but still the American entomologist found a number of laboratories intensively studying all aspects of the pests and diseases of corn. On inquiry he was informed that Germany intended to encourage corn cultivation but before that an organisation was being built up to meet any eventuality in case of the incidence of pests or diseases.

The Necessity for Plant Protection: An attitude of complacency on the part of the intelligentia combined with the proverbial conservation and an ingrained fatalistic outlook of our agricultural population have been mainly responsible for the neglect of Plant Protection in India.

The dislocation of foreign trade and food imports, economic and political upheavals, the world over, during and after the war have thrown us back on our own resources to prod ucesufficient

food for our ever-increasing population—*and we have failed.* We have retrogressively cut down our ration from 16 oz. to 12, from 12 to 8 and now from 8 to 7 oz. of our staple diet, rice. Gigantic efforts have been made and are still in progress costing the State crores and crores of money in the various schemes under the 'GROW MORE FOOD' campaign, with no palpable improvement in the overall situation.

It will be worthwhile to analyse the causes of this failure of our efforts, from the view-point of a Plant Protection Scientist. The practice of farming is one of the main causes for the upsetting of the balance of Nature. The more intensively farming is conducted, the greater is the interference with Nature. The use of specially evolved seed material and the practice of heavy manuring schedules to force abnormal yields are still further factors against Nature. And nature in her attempts to set right the balance reacts by favouring the abnormal multiplication of pests and diseases which subsist on these artificially raised and nurtured crops. We, in our efforts to increase agricultural production are creating exactly these conditions best calculated to favour the enormous increases of crop pests and diseases. We in our efforts to grow more food are actually and actively, even though unconsciously, partaking in "GROW MORE INSECTS" and "GROW MORE DISEASES" campaigns—and these have been to a very large extent successful. Tractors and pumpsets, ammonium sulphate, superphosphate and oil-cakes have been fully utilised by insects and diseases and the expected surplus has but gone to feed some additional millions of tiny mouths and insignificant spores, to make them strong to invade the next crop. The situation has so drastically changed over the last 10 years that we now very seldom hear of any crop that was not threatened by some insect pest or disease. The situation is bound to deteriorate with every passing year unless the Government realises and that quickly, the fundamental importance of Plant Protection as the most vital factor in their scheme of agricultural recovery and food self-sufficiency. The three-legged stool of agricultural progress can never stand stable on its two legs; all the three legs must be equally long and strong.

The Present Organisation and its Achievements: Since 1949 an organisation with 4 officers and 2 assistants in each district has been set up in this State for plant protection work, This set-up is hopelessly inadequate, considering the vast amount of work. The consolidation of even this meagre staff into an independant section, the creation of a wide and efficient network of skilled field-staff in the districts and the provision of mobile units for quick transport of men and materials are three urgent needs if the work of plant production is to expand. And it is my plea, that all these or at least a major portion of it could be done, with the resources and staff now in the department, without involving much of extra cost to the Government.

We have during the past 15 months treated about 8,000 acres against the army-worm of paddy, 2,000 acres against the green jassid of paddy, about 4,000 acres against the paddy grass-hopper, and more than 50,000 acres against field rats. Against the outbreaks of other paddy pests like Hispa, Leptispa, Tetroda and Rice-bug an area of nearly 2,500 acres have been tackled. In regard to millets, about 500 acres have been treated against the cholam earhead bug and more than 2,000 acres against the cholam grass-hopper. Brinjals, which is one of the staple vegetables of South India have been treated on nearly 1,500 acres and chillies in over 3,000 acres, Potatoes which are seriously damaged by cutworms and rats in the field have been treated in over 2,000 acres. Nearly 10,000 mango trees and nearly 5,000 citrus tree have been sprayed for various pests. These are only a few of the important items in the work of this section and is by no means exhaustive.

Though the above is a really creditable achievement it has but touched the very fringe of the problem of plant protection. Without a specially trained field staff in every district and without provision of mobile units for the quick transport of men and materials, plant protection can advance but little further than what we have been able to achieve so far.

The Problem of Stored Product Pests: Closely allied to the problem of crop pests and diseases in the fields is the safeguarding of the harvested produce in granaries and stores.. This causes a most tremendous drain on our food reserves; it needs no emphasis or explanation since it is made so blatantly obvious to every ration card holder by the frequent issues of rations, far advanced in insect damage. Government storage centres deal only with a small portion of the total agricultural production of the country, the bulk of which is in the villages and no work has been done so far to improve the conditions here. It is an absolute necessity to strengthen this aspect of plant protection to ensure a balanced agricultural economy.

Legislative Measures as aids in Plant Protection: Before closing the subject, there is another important aspect of plant protection, namely, the role of legislative measures as aids in this work, which needs consideration. The adoption of control measures in a large area, at times of insect outbreaks is sometimes seriously impeded and very often completely obstructed by the perversity of a few isolated individuals who by their refusal to adopt any measures, lead not only to the destruction of their own crops but afford fertile centres for fresh infection. It is urgently necessary that such individuals should be prevented from indulging in this sort of unsocial acts and in Madras we have an effective instrument to prevent them in the Pests and Diseases Act of 1925. It is highly necessary and even imperative that the provisions of the above Act

should be enforced in respect of every major pest of every crop in this State. Of course such an action will be unpopular; compulsion in any form is always unpopular but it has to be resorted to for the general good and welfare of the public. The fact of having the Act promulgated does not mean that we desire to indulge in indiscriminate prosecutions and harrassments but for the field worker it is always helpful to have such a measure in the background.

A fresh legislative Act is necessary in respect of stored food products. It is agreed on all hands that stored food losses due to insects, both in quantity and quality are enormous.

It is the prime duty of the State to interfere and rectify such an obvious case of mismanagement and minimise this sort of preventible waste. At present the State is helpless to compulsorily prescribe any safety measures or enforce any standards for ensuring correct storage. It is quite essential that a legislative Act should be passed in this respect.

Conclusion: Intensive cultivation to maximise our agricultural production is an absolute necessity and will be of more and more importance to our national economy with every passing year. The efforts made so far have not had the amount of success commensurate with the expenses incurred and the labour expended. This is principally due to the non-recognition of the enormous waste caused by insect pests and diseases in the field and in the stores. In our efforts to feed our increasing millions we are but feeding increasing millions of insects and disease germs. As Sri K. M. Munshi, Food and Agriculture Minister Government of India rightly stated recently, 25% of the food production in the country is being wasted because of the carelessness of the cultivator. The easiest and quickest means of attaining food self-sufficiency is to prevent this avoidable waste, which is much larger than the actual deficit. The plant pests and diseases are our dangerous rivals for the food supplies of the world and whether we hope to survive and exist for the next 50 years will depend to a large measure upon the success or failure of a well-planned and organised plant protection service.

Groundnut in Madras; Maximisation of Production

By

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I propose to deal with the subject in two parts; first about maximisation of production in general and then about the groundnut in particular.

Necessity for increased production: As in most parts of the world, in this country too, almost all commodities required by man, particularly foods and grains are in high demand and short supply. This situation has caused prices to soar up abnormally high, with the result that the lower and the middle classes are very hard hit. The standard of living is going down with consequent repercussions on health, society, State economy and public relations. In a country like ours where yields are low and famines are always staring us in the face, the necessity for increased production of all commodities is always there. While the world figure is 1·5 acres of cultivated land per head of population, the figure for this country is only about an acre, which is rather low, and on the other hand population is increasing at rather too rapid a rate. Therefore the need for increased production of crops is much more urgent in this country than in most other parts of the world.

How can this be achieved? Crop production is a result of many factors operating viz., land and soil, climate and weather, seed, manure, water, pests and diseases, labour and also other economic considerations as demand and supply, and price levels. Some of these for example, weather, are beyond the control of man. If production has to be maximised we have to lay more stress on and pay more attention to factors which we can control and operate. The first consideration, naturally is land; more cultivated land means more production. This is more easily said than done. Still it is possible to get a few lakhs of new land under the plough. On this subject, I presented a paper at the 1948 Agricultural Conference with special reference to the West Coast. I pointed out that considerable areas of marginal and sub-marginal land could be cultivated with rice if we can only work the tractor and the bull-dozer. This apples to the East Coast as well. But poor land is not an asset and unless it is properly manured, remunerative crops cannot be grown. This leads us to the consideration of manures and manuring. These are also in short supply. Apart from the all-important organic manures as green manure, farmyard manure and composts, three classes of manures which are essential to crop production should be considered. These are phosphatic, potassic and

nitrogenous manures. Our phosphatic deposits, though not in an immediately available form, may last us a few centuries yet, and with some research to get tri-calcic into more easily available forms it may not be difficult to tackle our phosphate problem. As regards potash most of our soils except those in the West Coast and in the hills are not lacking in it. The real difficulty is with nitrogen; but there are vast stores of it in the atmosphere. Sooner or later we have got to tap our atmospheric resources of nitrogen and the sooner we do it the better. This is a matter, the technical side of which concerns the chemist primarily and I am sure he will have a say on the subject. But I would like to stress on one aspect of nitrogen supply for our immediate needs. There are large deposits of humus in our forests and it should be possible to make it available to the agriculturist in the plains at reasonable prices wlthout in any way affecting the well-being of the forest itself; of course preliminary research has to be done on the practical aspect of the problem viz., manurial value and suitability to different crops. Also in this connexion the importance of trace elements in combating deficiency diseases may not be overlooked.

The most important and primary consideration in any programme of maximisation of crop production should be intensive cultivation. That is, as much area as possible should be grown with crops aiming at the same time to obtain as high a yield as possible. With this end in view the cropping scheme has to be drawn up, representing every aspect of crop production. Intensive cultivation is possible only when the water requirements of crops can be satisfied. There must be sufficient water as and when required. This is the great limiting factor. We cannot rely entirely on rainfall, which is usually precarious in many places of the country. Therefore, it is a matter of paramount importance that all our water resources are investigated and fully made use of. Water is our best ally in increasing crop production, at the same time, it may turn out to be an enemy when it is not controlled, as is evident during floods. Thus it follows that our rivers should be harnessed and the water utilized to the fullest possible extent. Take the instance of the mighty river Godavari. In season, there is enough and more water but we have not been able to make use of even a fraction of it. More than 90% of the supply goes waste, inspite of the Douleshwaram anicut, when vast areas could have been profitably cropped by making use of the water. This is an anomalous situation and can be remedied by constructing more dams and reservoirs. Take another instance from the West Coast. The rainfall is very heavy during the South-West monsoon ranging from 100-150 inches and there are also a number of small rivers running into the sea. All this water is practically wasted except for raising the rice crop during the South-West monsoon. Garden crops are practically unknown, the soil is too much leached out, there is dearth of even drinking water in some places during summer and the people in general are poor and the standard of living is

low. All this can be prevented by harnessing the water reservoirs and intensifying agriculture. Thus the crux of the whole problem is water and more water and water which we can command and use as and when we need it. By the way, it may be mentioned that more water means more electric power which is the mother of all industries.

Improved strains of crops: In the maximisation of production, the importance of improved strains cannot be emphasized too much. Most strains of crops in Madras are known to give an increased yield of about 20% and more over the locals. If all the cultivated area can be sown with only improved seeds, the amount of increased yield will obviously be very considerable. But we do not have strains of every crop suitable to and satisfying the needs of every tract. And even in the strains we have, the quantity of seed available is very limited, though there is considerable demand for it. Therefore more improved strains and more seed of such have to be produced on a large scale to meet the demand from all over the country. This means that we should have a large-scale programme of research at more regional research stations to evolve high yielding strains, and more seed multiplication schemes. These two branches of work should go together and one is incomplete without the other.

Seed Testing: This aspect of the subject primarily concerns itself with the quality of seed meant for sowing. Quality consists mainly of high percentage of germination and freedom from foreign matter such as seeds of weeds and dirt. The loss sustained by the country, by sowing seed of low germinating percentage is considerable. It is a double loss, because it neither serves the purpose of sowing nor the needs of man for consumption. This loss can be saved by having seed testing units in every tract so that only seed of tested quality can be sown and that which is unfit for sowing can be put to other uses by the people. This important branch of agricultural research does not seem to have received attention in this country and it is time the subject is taken up.

Storage of Seeds: Along with the maximisation of production the problem of storing seeds also should be considered. When there is large-scale production, there will be years when surplus produce is bound to accumulate which has to be stored carefully for future use without deterioration and damage by insect pests and vermin. For every kind of grain it has to be determined, based on research, how long it can be preserved for seed purposes and for consumption without deterioration. The kind and nature of receptacle and the precautions to be taken against insect attack have to be determined both for small-scale storage by individuals and large-scale storage as in godowns. Though it is well known that the loss caused to stored products in this country is very

considerable, no systematic work on the subject seems to have been attempted in respect of farm produce and it is very desirable that the work is taken up with a view to saving much avoidable waste.

Marketing and Prices of farm produce: The most important consideration in this context of increased production is that the produce is made available to the people by whom it is urgently required for consumption, at reasonable prices. We are not planning to step up production for the benefit of the traders to profiteer. At the same time, the price of produce should induce increased production. These are aspects which have to be considered at a higher level than an agricultural conference and are therefore, not dealt with in detail here.

II. The Groundnut in Madras

The groundnut is now one of the principal oilseed crops of the tropics and of India. The native country of groundnut is said to be Brazil. It was reported to have been introduced into India in the 16th century but did not come into prominence till the middle of 18th century. The first four decades of the present century witnessed a phenomenal increase in the acreage and production of the groundnut in India. It is, at present, the most important money crop of the dryland ryot in Madras. It has literally yielded crores of rupees to the poor Indian ryot and also secured for the country a place of importance in the international oilseeds market.

Importance of the Crop: The great importance which the crop has attained in the economy of man is due to the fact that it is not only a cash crop but also a food crop. The seeds contain about 50% of oil of excellent quality (by chemical extraction) 27% of protein and have very high calorific value viz., 561. It is not only a food for man, but also food for cattle and at the same time, a renovator of the soil. It is not only an industrial crop but also a preserver of soil for it is a very good cover crop which can prevent soil erosion on account of the numerous pod-forming pegs driven into the soil. Every part of the plaint can be put to some good use or other and also to a variety of uses. It is a multipurpose crop. There is no wonder then, that such a useful plant is called the wonder nut.

Area and Production: India is the largest producer of groundnut in the world with 40% of the world's production. And Madras owns 4 millions of acres or 40% of the area in India, with 46% of India's production, valued nearly 100 crores of rupees a year for Madras alone. Therefore, it is the first money crop in Madras and then comes cotton whose annual production is worth only about 48 crores of rupees. At one time, India was exporting (1933-39) as much as 1.2 million tons of seed. But now the internal demand for groundnut seed, oil and cake has increased so much that we are unable to export any appreciable quantities with the result

that our foreign assets are dwindling and our erstwhile customers are turning their attention to other countries and also making great efforts to produce their own requirements. Under these conditions we may lose our world market.

Future of Groundnut: When the prices for groundnut go down, as they are bound to, in due course, due to increased production of other oil seeds, a time may come when there will be no incentive for the cultivation of groundnut and the crores of rupees our people are now earning will not be there then. That would certainly be a calamity to the country. Therefore, it is a matter of paramount importance that groundnut production should be stepped up immediately in this country, so that we can have an exportable surplus and the much-needed foreign exchange. Then, there is the world shortage of fats and oils.

Target: The Panel on Oils and Soaps have recommended that the target of groundnut production in India be fixed at 5.4 million tons of nuts in shell i. e., about 2 million tons of nuts more than the present output of the country.

How to attain the Target: It is not an easy matter to attain this target unless an all-round attempt is made to step up the present production by about 60%. This means that every possible effort should be made with that object in view. In the first place, it is not possible to increase the area under groundnut without encroaching on the area under main food crops. This is obviously not a feasible proposition. Therefore recourse should be had to direct our efforts to intensive cultivation, adopting every known method of crop improvement.

Seed rate: The normal seed rate for groundnut should be 80-100 lb. of kernels or seeds per acre. This is quite high, considering the yield which is only about ten times the seed rate. Therefore, to make the limited seed available, go a long way, there is a tendency in most parts of the country to adopt lower seed rates. But then the crop will be gappy and the yield will be correspondingly low. The ryots or farmers should be made to realize the importance of proper seed rate. The seed should be tested for viability and only seed with high percentage of germination should be sown.

Mixed Cropping: Groundnut can be sown as a mixture with other crops viz., cotton, cholam, cumbu, tenai, castor and red-gram. Such cropping has been found to yield better money returns per acre than pure cropping.

Rotations: There is a tendency among our ryots to go on cultivating groundnut year after year without rotation. This is not desirable as the soil will be depleted of certain manurial ingredients

and the yields are bound to go down. It is therefore necessary that proper rotation is adopted with cereals like, cumbu, or cholam, or tenai and also cotton, castor or redgram.

Most of the area under groundnut in Madras is grown under rainfed conditions and rainfall is often precarious and uncertain. Groundnut responds very well to irrigation and if there is sufficient moisture in the soil a rich harvest is assured. A sure way of increasing the area and production of the crop is to rotate it wherever feasible with rice under which there is quite a large area in the country. In Madras alone the area under single-crop rice is about 8 million acres and a part of it, can be cultivated with groundnut after the main crop is off the field. It is however important that there is sufficient moisture in the soil after the groundnut crop is established. A few summer showers will be helpful or recourse will be had to irrigation.

Improved Strains Improved strains yield more than the local and have other economic characters also, such as high shelling percentage, natural test weight, oil content, resistance to drought etc. In Madras we have three well-established strains of proved merit. They yield 20 to 25 percent. more than the local. So, if we can replace the local by the improved ones, certainly the production can be stepped up. But at present such a proposal is practically impossible, because the quantity of nucleus seed that can be produced at the Groundnut Station, Tindivanam, is very limited viz., 40,000 lb. per year and it is sufficient to sow only about 400 acres of primary seed farms. Further, the rate of multiplication of the seed in the districts has been rather very slow for some reason or other. If the benefit of improved strains should reach the farmer, the work of seed multiplication shovld be planned and carried out on a much enlarged basis on a regional scale, by properly qualified staff who can attend to the work efficiently. The seed has to be made available to the farmer as and when he requires it for sowing. Proper arrangements have to be made to get the produce from primary seed farms in time and distribute it for sowing in secondary seed farms. A sound organisation for proper production and distribution of the seed is now lacking.

Research: Research is the basis of all progress. For crop improvement and maximisation of production, research on various aspects is essential. At present there is only one Agricultural (Oilseeds) Research Station for the whole of the Madras State and it has to work on all the major oilseeds of the State viz., gingelly and castor besides groundnut. Three useful strains in each of the crops have already been evolved. But these have done better in the southern districts than in the north. The Andhra districts which have about 60% of the area under groundnut in Madras are not much benefited by the work done at Tindivanam in South Arcot. The strains suitable for the Andhra districts have to

be produced in that tract itself. A short-duration bunch variety of groundnut with dormant seeds is urgently required not only for the northern districts but also for the Pollachi tract. Much work yet remains to be done on the agronomic and plant protection side. Research on groundnut has to be taken up on a regional basis. The work involved is so very considerable and extensive that a separate specialist assisted by sufficient staff and facilities should solely devote his attention to tackle the various problems pertaining to the crop. It is a crop which has given us millions of rupees and it is but proper that research on such a crop is intensified in our own future interests. It is a sure investment, certain to pay us good dividends in the near future.

Summary: The necessity for producing crops on as large an area as possible on an intensive scale in view of our increase of population is stressed. The steps to be taken, to achieve the end are stated. Every improvement research has contributed towards increased crop production and every known method of doing it has to be pressed into service to maximise the yields of crops. More land has to be made available for cultivation by reclaiming marginal and sub-marginal land. The importance of manuring in this connexion is well known but manures are in short supply. Nitrogenous and organic manures are the most urgently needed. The possibility of tapping our humus deposits from certain forests for immediate requirements has to be considered. Atmospheric nitrogen will have to be made use of in the manufacture of artificial manures. The first desideratum is water and all our water resources as rivers should be fully utilized by having more irrigation projects. That improved strains of crops available can contribute to step up production is well known. But an efficient organization to multiply and distribute such improved seed is urgently required. The country is sustaining very great loss by sowing seed of doubtful quality. To prevent this avoidable loss, seed testing units are immediately wanted but are not available. Storage of farm produce has to be seriously taken up and efficient methods devised. Reasonable prices for farm produce have to be assured and sufficient inducement to grow more crops on an intensive scale has to be provided. Also crop protection services have to be extended.

Groundnut in Madras: In the context of stepping up production groundnut should receive top priority next only to staple food crops, because it is a multi-purpose international crop capable, of giving food for man and cattle and oil for industry. It is the first money crop yielding nearly 100 crores of rupees annually in the Madras State alone. Also it can give the much-needed foreign exchange. India is the largest producer of groundnut in the world and Madras holds a unique position with 4 million acres under the crop and 46% of India's outturn. But our exports are dwindling and there is a serious danger of our losing the world's markets and

foreign assets for want of sufficient surplus, and there is a world shortage of edible oils. The Panel on Oils and Soaps have recommended an increased production of about 2 million tons of nuts in shell. To save a serious situation we have to increase our exportable surplus of groundnut urgently, and also for the ever-increasing internal consumption. This has to be brought about by every possible means at our command. It is not quite practicable to increase the area under the crop but it can be introduced into the rotation of crops with cereals, pulses and cotton. In single-crop wet lands it can be grown after a first crop of rice in large areas of the State where facilities exist. The high-yielding, improved strains of groundnut now available have to be multiplied on a large scale and distributed among farmers so as to replace the less paying local forms. An efficient organisation to carry on this line of work is required.

Evolution of strains suitable for the large groundnut tract of the Andhra districts is an urgent necessity. Research on every aspect of groundnut production has to be intensified under a whole-time Specialist with sufficient staff, and facilities on a regional basis. Money invested on groundnut research is sure to be fruitful and benefit the country in no small measure.

Maximising the production of Gingelly in Madras

By

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Introduction: Gingelly (*Til*) or Sesame (*Sesamum indicum* Linn.) is one of the oldest of oilseed crops of the tropical and sub-tropical countries of the world. According to Hildebrandt, the plant is supposed to have originated in Southern and South-Western Africa. However, considering the large diversity of forms met with under cultivation, India and Japan are recognised as important secondary centres of origin. In India the plant has been under cultivation as an oilseed from time immemorial.

The sesamum plant is cultivated for its seeds which contain about 50 per cent by weight of an edible oil of excellent quality. The oil is largely in demand for culinary purposes, especially in South India and to a lesser extent for soap making. Many medicinal properties are also attributed to the oil. In fact it is the base for the preparation of a variety of medicated oils in Ayurveda. An impressive list of medicinal uses attributed to the different parts of the plant in India and elsewhere has been given by Kirtikar and Basu in their "Indian Medicinal Plants". In America and Europe, gingelly oil is reported to be utilised in the manufacture

of oleomargarine, shortenings, cooking oils, soaps, paints and drugs. One of its important new uses is as a carrier of the wonder drug penicillin. Sesamin, a constituent of the oil has been definitely established to have the property of enhancing the insecticidal potency of pyrethrum.

The whole seeds are also nutritious. It has a calorific value of 564 and a vitamin A content of 107 international units, per 100 gm., and is considered a rich source of calcium and iron. The seeds from a common ingredient in many kinds of sweets and confectionary preparations.

The residual cake or meal left after the expression of oil is a concentrated feed for milch cattle. The cake contains about 6 per cent nitrogen and can also be used for manurial purposes. However, the entire quantity produced in India, estimated at 1,300,000 tons is utilised at present as cattle food and no quantity appears to be diverted for manuring crops. Moreover, the production is insufficient even to meet the demand for feeding cattle. Cake from polished seeds is used for culinary purpose in the Circars.

Area and Production: The annual world production of gingelly seeds is estimated at 2 million tons, 80 per cent. of which is accounted for by India and China. The Indian Union with an annual production of about 3 8 lakhs of tons is second only to China which ranks first with 4 6 lakhs of tons. In India the crop occupies nearly 4 million acres i e., about 16 per cent. of the area devoted to oilseed crops, and ranks third in importance among the principal oilseed crops grown in the country. Uttar Pradesh leads the other States accounting for as much as 33·3 per cent. of the area and 31·6 per cent. of the production of India. The Madras State comes next with 17 7 per cent. of the area and 20 7 per cent. of the production. Her annual out-put is estimated to be about 80,000 tons from roughly 7 lakhs of acres. The area devoted to the crop works out to nearly 13 per cent of the total area under oilseeds in the State. The Circars comprising the districts of Visakhapatnam, East and West Godavari, Krishna and Guntur, account for over 50 percent. of the gingelly area in the State. The district of Visakhapatnam alone posseses over 1·3 lakhs of acres.

Utilisation: Prior to World War I, India was an exporter of gingelly seeds to the tune of about 1 lakh of tons per annum. In recent years the export has dwindled considerably; during the period 1946 to 1948 the quantity exported averaged only about 1,000 tons per annum. The consumption in the country has gone up but the production has not correspondingly increased with the demand. The net result is that not only is there no surplus left over for export, but there is even a widespread shortage of the commodity in the country.

Out of the total production of about 3·8 lakhs of tons of seeds in the Indian Union, 3 lakhs of tons are estimated to be crushed, yielding about 1 2 lakhs tons of oil. Out of this 7,500 tons are reported to be used for Vanaspathi manufacture, 80,000 tons for edible and 20,000 tons for hair-oil and other non-edible, domestic purposes.

The Present Position in Madras: Gingelly oil is the principal oil used for culinary purposes in the Madras State with the exception of Malabar and South Kanara districts where coconut oil is preferred. The oil is also used in appreciable quantities for anointing the hair and body while taking an oil bath, a custom which is prevalent among the people of South India. In recent years

there has been a steep rise in the price of this oil in the Madras State. The index number of the price prevailing towards the end of April 1950 ranged from 390 to 674. The high cost has placed gingelly oil out of the reach of the lower strata of population, who have naturally been forced to take to relatively cheaper oils like groundnut oil.

Even in normal times gingelly is in short supply in the Madras State and quantities averaging a little over 25 000 tons of seed i. e., 30 per cent of the production is annually being imported into the State from Orissa, Hyderabad and Uttar Pradesh. There is very little export of gingelly seeds from Madras and therefore the entire quantity produced in the State and that imported from outside, totalling to a little over a lakh of tons is consumed in the State itself. Consumption is mostly in the form of oil, as 90% of the net available quantity is utilised for crushing. There is no import of gingelly oil into the State from outside Therefore the present quantity of oil consumed annually in the State can be taken to be somewhere about 40,000 tons. This falls considerably short of the State's requirements as will be clear from the succeeding paragraphs. It is therefore very necessary that attempts should be made early to step up internal production.

Target of Production to be aimed at. Before dealing with the measures that are to be taken to increase production, it is necessary to have a general idea of the States' requirements. In the absence of reliable data this is obviously a difficult task. Moreover, there are two ways of approaching it. Are the plans to be drawn up with an eye to the future or are they to be drawn up with reference to immediate needs ? The rational approach will be to draw up an integrated plan which will include both short-term and long-term measures, that will fit in properly with each other.

Since gingelly oil is largely consumed only for culinary purposes, our aim for the present needs take into consideration only its requirements for edible and anointing purposes Any surplus left over alone should be allowed to be diverted for industrial uses. The Nutrition Advisory Committee has recommended 2 oz. of fat or oil as the minimum per capita, per day consumption. Though this level of fat consumption should be our ultimate goal, it may well be considered as ambitious in view of the present economic conditions prevailing in the country. However,as the standard of living of the people improves, and people become more and more nutrition conscious, the consumption of fats among the population is bound to go up. Provided unadulterated gingelly oil is made available in adequate quantities and at a cheaper price, there is every reason to expect an ever-increasing popularity for the oil, resulting in increased demand. It is not suggested that gingelly oil is the only form in which fat is consumed in the country. In the higher income groups ghee might be the chief source of fats, while those in the lower income groups might go in for cheaper oils like groundnut oil, niger seed oil, safflower seed oil, etc. Vanaspathi or hardened vegetable oil may also to some extent satisfy the requirements of fats.

Considering all the above factors, it may not be out of place if we aim at a per capita per day, requirement of 1 oz. of gingelly oil. Even assuming that only 30 out of the 50 millions of Madras State are habitual users of gingelly oil or will take to it if the supply position improves, the State's annual requirements of oil can be reckoned at 3 lakhs of tons as against the present consumption of nearly 40,000 tons. The extent of leeway to be made up can very well be imagined if we have to attain eventual self-sufficiency in regard to gingelly oil. To get this quantity of oil nearly 8 lakhs of tons of gingelly seeds have to be utilised for crushing. Taking into consideration the quantity of gingelly seeds consumed as such and also the quantity that has to be reserved for seed purposes, the target of production in the State to be aimed at is nearly one million tons. It may well be that these figures are exaggerated and wide of the mark. They have been referred to here only with a view to emphasizing the fact that the requirements of gingelly seeds in

the State in future are likely to be considerable, provided all the factors for the increased consumption of fats are favourable. It is also not suggested that the high target can ever be achieved in the State. Even the Panel on Oils and Soaps constituted by the Government of India has recommended only an increased production of 6 lakhs tons for the whole of India. There is, however, no doubt that the present position admits of considerable improvement.

The Scope of Increasing Production. The foregoing paragraps would show the urgent necessity to increase the internal production. The next step is to examine the various measures that will help to step up the production. The ways open to us are either to increase the area under the crop or to increase the yield per acre or both.

Increasing the area: Increasing the acreage devoted to the crop in the State will naturally be the step which will suggest itself first. The present indications are that, though possibilities exist in this direction, they are not capable of being exploited for the purpose with any degree of confidence. A perusal of the figures for the area under the crop in the State for the past 15 years shows that though the area fluctuates considerably from year to year, the trend is definitely downward. During this period there has been a decrease in acreage by about 3 per cent, but the more disquieting factor is that the production has gone down by as much as 15 per cent. This is not surprising in view of the fact that out of the total estimated normal area of 7 lakhs of acres in the State, only one lakh of acres is raised under irrigated conditions which gives a sure crop. The remaining area is raised under entirely unirrigated and rainfed conditions. The area sown to the crop depends considerably on the receipt of rains at the proper time for sowing and the yield is influenced by the climatic conditions prevailing during crop growth and the incidence of pests and diseases The crop being a delicate one, it easily succumbs to any adverse conditions. The seasonal conditions have in fact been generally unfavourable for the crop throughout the State for a number of years. The seasonal factor has not been quite normal during the past 15 years, being 80 to 90 on a number of occasions. The fall in production is therefore only to be expected.

A limited increase in area is possible by adopting the following measures. The crop can be introduced in single-crop wetlands after the first crop of paddy. This method of cropping is already in vogue in certain districts, particularly in Visakhapatnam and may well be introduced where conditions are favourable and admit of such a practice. The extent of area that could possibly be brought under this system of cropping can be ascertained only after a detailed survey of the different districts. With the expansion in the irrigated area that is bound to follow when the various irrigation schemes in the State are completed it should be possible to increase the area under the gingelly crop also. There is also a possibility of taking a short duration gingelly crop after the harvest of the main crop of groundnut or cereal raised in drylands during the rainfed season. This practice is very common in the red loamy soils of South Arcot district and can with advantage be extended to most of the other Central and Southern districts of the State. Nearly one lakh of acres can be brought under this system of cropping, provided conditions are favourable, and seeds of suitable varieties are made available in sufficient quantities and in time. The area actually sown and the yield obtained will however depend to a large extent on the receipt of adequate and timely rains during the North-East monsoon period and one or two showers in January–February. The precaution suggested in regard to the choice of suitable varieties is very necessary as gingelly is a season-bound crop and all varieties are not capable of coming up well in all seasons. A gingelly strain suited for cropping during the cold weather has recently been evolved at the Ground nut Research Station, Tindivanam. This should facilitate the popularisation of this system of cropping among the ryots.

The introduction of gingelly as a mixture crop in the drylands on a wider scale than is being done at present will also help to increase the area under the crop. This practice is very extensive in Uttar Pradesh and may be followed in this State also.

Increasing the Yield per Acre. It has been shown that though possibilities of increasing production by extending the area under the crop exist, they are rather uncertain as long as the crop is under rainfed conditions. A better and perhaps a surer approach to the problem will be to increase the yield per acre. In this direction the possibilities are immense, though much time, effort and money may have to be expended to reap the maximum benefit. The average yield per acre of gingelly in the State as per the Season and Crop Reports is about 300 lb. This does not appear to have been based on the results of any systematic crop-cutting experiments, and in reality appears to be fixed a little too high. Extensive study of the practices followed by the ryots at present has revealed a number of defects. The improvements suggested below will help to increase the yield per acre.

1. **Prepare a good seed bed:** To ensure proper field germination, the soil should be worked to a fine tilth and care should be taken to see that adequate moisture is available in the soil at the time of sowing. These are not being done now.

2. **Sow a variety adapted to the environment:** Gingelly is a season and tract-bound crop and varieties behave differently according to tracts and seasons. Thus many varieties are met with under cultivation in the different parts of the State Most of the ryots out of long years of experience, know exactly what varieties to sow under particular conditions. However, when cultivation is taken up in new localities, sufficient care has to be bestowed in choosing a suitable variety for cultivation.

3. **Use good seeds:** Seeds having good germination percentage alone should be used for sowing. The stand of plants depends a good deal upon the viability of seeds. This precaution is particularly necessary in the case of gingelly seed which is extremely susceptible to severe insect attack in storage. Viability is poor in insect damaged seeds.

4. **Provide adequate stand:** Optimum stand of plants per unit area is necessary to obtain maximum yields. When more number of plants than this limit is allowed to grow there is competition among the plants for the available plant-food with the result that the yield gets reduced. When the plants are few, growth is usually more vigorous but the yield per plant is not adequate to compensate for the fewer number of plants. The optimum number may vary with the variety, the conditions under which the crop is grown, the fertility status of the soil etc and has to be fixed with reference to the conditions prevailing.

Poor stands of crops is a common feature in the cultivators' fields and gingelly is no exception The poor stand may be due to a variety of causes such as using low seed rate, poor germination arising out of the bad quality of the seed. want of proper tilth and moisture in the soil and incidence of pests and diseases. Instances where the plants are too crowded are also equally common. This arises out of the fact that the ryots use a higher seed rate than is actually necessary in order to safeguard against likely unfavourable conditions but do not care to thin out the plants later on when the conditions are favourable. Thinning in such cases is essential in order to induce better branching and setting of capsules. Educating the ryot in this line is sure to bring good dividends.

Manure properly: Gingelly crop is an exhaustive crop and naturally will have to be provided with adequate plant food if satisfactory yields are to be obtained. At present the crop is seldom directly manured, it being left to grow with the residual effect of the manures applied to the preceding crop. Adequate and direct manuring may help to increase the yields.

Attend to regular weeding: Ryots seldom do any systematic weeding of the crop. Weed competition especially in the initial stages, affects the growth and yield of plants. A hoeing and weeding between the 20th and the 30th day after sowing has been found to be very necessary and beneficial. The ryots may well pay more attention to this aspect and they will be benefited.

Control pests and diseases: The gingelly crop in the State in subject to the attack of some destructive pests and diseases The most important insect pest of gingelly crop in the field is the shoot-webber (*Antigastra catalaunalis*). The pest assumes serious proportions in periods of drought and often devastates the entire crop. Where the infestation is mild, application of calcium arsenate and lime (1 : 6) has sometimes given good results.

Among the diseases, the most serious is the "little leaf disease" or Phyllody. The disease is characterised by the proliferation of reproductive parts into vegetative structures. This is prevalent in most of the gingelly tracts in the State The disease has been observed to occur in a more virulent form in the irrigated crop and no yield can be expected in such cases. The causative factor for the disease, the nature of its spread and measures to be taken against it are all practically unknown and merit investigation without delay. For the present, removal and burning of the plants showing early symptoms of the disease is recommended as a control measure.

Gingelly Research in Madras: The improvement work of gingelly in Madras was initiated only in 1931, with the establishment of a separate section under an Oilseeds Specialist to deal with the principal oilseed crops of the State. The work is being done at the Groundnut Research Station, Tindivanam along with that on groundnut and castor. The staff and facilities being meagre and greater attention having to be paid to groundnut, work on gingelly had perforce to be restricted to the evolution of improved strains only. The vast field of cultural, manurial and pests and diseases investigations is practically untouched. Inspite of such handicaps some results of practical utility to the ryots have been achieved. They are, in brief, the following:

1. **Evolution of high-yielding strains:** As a result of intensive selection and hybridisation work, three strains with high yield and good quality of produce have been evolved. Strain T. M V. 1 has been found suitable for growing during the rainfed season. T. M. V. 2 is a slightly shorter duration strain which has been found to come up well in the cold season (December to March). This has in addition to the high yield, the desirable characters of high oil content, dull white seeds and partial splitting of capsules which prevent shattering of seeds at maturity. Strain T. M. V. 3 is particularly suited for summer cropping under irrigated condition. This also contains about 2 per cent more oil than the local varieties.

Trials so far conducted have shown that these strains are suited to the Central and Southern districts. They have not done well in the Circars, Ceded Districts and Malabar where the conditions are quite different.

2. **Optimum spacing:** It has been established that on red loamy soils the optimum spacing for a gingelly crop raised under purely rainfed conditions is 9"x9" and that raised under irrigation is 1'x1'. The optimum seed rate per acre is about 5 lb. for a rainfed and 4 lb. for an irrigated crop.

The Programme for the future. The account of the work done so far will show that much more remains to be done. The following are some of the more important problems awaiting investigation. On the successful solution of these will depend the progress the State can make towards achieving the goal of increased production. The sooner these are tackled the better.

1. **Evolution of strains:** Though the strains already under distribution are yielding better than the local varieties there is considerable room for effecting further improvements. An ideal strain is one with high yield, high oil content, non-deshiscent capsules, uniform maturity and possessing resistance to drought, shoot-webber pest and phyllody disease. Duration and colour of seeds may have to be varied to suit regional requirements. These are easily said but may take years to be brought together in a single strain.

2. **Determination of the optimum manurial and cultural requirements:** The most remunerative and optimum preparatory and intercultivation practices and the manurial requirements of the crop will have to be determined with reference to soil types and seasonal conditions. No reliable information is at present available on these aspects.

3. Spotting out of suitable mixtures: The popularisation of growing crops mixed with gingelly whereever possible has been suggested as one of the ways of increasing the acreage under the crop. However, before advocating this practice it is necessary to gather information regarding the probable areas where this can be introduced and to spot out compatible and remunerative mixtures for the different areas.

4, Control of pests and diseases: The evolution of high-yielding varieties resistant to pests and diseases is undoubtedly the most acceptable and desirable way of solving this problem, but this is an item of long-range research and may take years to achieve tangible results. Meanwhile, it is necessary to find out cheap and praticable control measures which are within the reach of the ryots, particularly to tackle the shoot-webber pest and phyllody disease.

The problems suggested above relate only to field investigations. No mention has been made on the extension side of the work, though it is equally important if the ryots have to enjoy the fruits of research. There are also problems like the storage and deterioration of seeds etc., which need investigation. The extent of damage caused to the seeds at present by insects and vermin during storage and subsequent movement from the producer to the consumer does not appear to have been sufficiently appreciated. Nevertheless, it is considerable. Any improvement which it is possible to effect here will make even the present supply available to a larger number of people.

Regionalisation of Research: Gingelly crop is now being grown under widely different climatic and soil conditions in the State and gingelly varieties are almost always tract and season-bound. As already mentioned the strains evolved at Tindivanam are not found suitable in the Circars, Ceded Districts and Malabar. The experience gained has underlined the need to conduct research on a regional basis if we are to secure improved strains or suggest improvements in the present method of cultivation and manuring.

Taking into consideration the immediate needs, the establishment of a Regional Research Station for gingelly improvement work in the Circars should receive top priority. Possessing as they do nearly 50 per cent. of the entire gingelly acreage of the State, the Circars have to be given more serious attention than what it has been possible to give so far. Similarly, work has to be initiated in the Ceded Districts also. Without regional Research Stations, to serve these distinct areas it may not be possible to make much headway in gingelly improvement in the State.

SUMMARY: Gingelly (*Til*) or Sesame is an important oilseed crop of the Tropics grown exclusively for its seeds, which yield an oil of excellent quality. The crop is cultivated to a large extent in the Indian Union, where it is ranked third in importance among the oilseed crops cultivated. The Madras State with a normal area of about 7 lakhs of acres under the crop and an estimated annual production of 80,000 tons of seed accounts for 17 7% of the area and 29 7% of the production of India. Gingelly oil is in considerable demand throughout the country, particularly in the Madras State, mostly for culinary purposes A review of the available statistics regarding the production and utilisation of seeds in the Madras State, has shown that the present production falls considerably short of her requirements. The possibilities of stepping up the internal production to make up for the present shortage and to provide for future requirements have been explored. Increasing the acreage under the crop, though feasible, is shown to have limitations, and unreliable as a basis for drawing up any definite plans. On the other hand, there is considerable scope to increase the yield per acre. The factors that go to make large yields in general are known but basic data on which specific recommendations have to be drawn up for adoption by the ryots are lacking as no research work has been done on this aspect. The contribution of the Oilseeds Section to gingelly improvement in the State has been referred to and the lines on which work should develop in future have been indicated. The need for doing research work on gingelly on a regional basis is brought out.

Some means to increase production of rice

By

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Introduction: The World War II has left its disastrous effects on every country. One such is shortage of food. Our country with its vast millions comprising nearly 1 5 of the world's population was even in normal times, an importing country in the matter of food grains. The present position is such that even if the world's production of rice is raised by 10 million tons it will not be possible to secure the prewar level of consumption in rice-eating countries as the deficit between production and consumption of rice is in the neighbourhood of 14 million tons. While there is an increase in the population of the country by 10 per cent, the yield of rice has been going down due to adverse causes as failure of monsoons, want of fertilisers and agricultural implements. Dr. Aldous Huxley says "That the only alternative to world-wide starvation is reduction in numbers almost everywhere and a world population policy based on birth control. Meanwhile the resources of applied science are to be mobilised for the relief of the world's hunger". Sir John Russell, while agreeing with the latter proposition maintains that the world can keep pace in food production with any foreseeable increase in population. It is possible that the truth lies in between the pronouncements of the two eminent scientists. Leaving aside the question of birth control to economists and politicians let us examine a few ways and means of increasing rice production in our country with special reference to Madras State.

It is often stated that the acre yields of rice in our country are very low when compared to those in other parts of the world. But it has to be remembered that in those countries which record higher yields than ours, the area under rice is not even as much as in some of the individual taluks of our State. Again, rice cultivation in such countries is confined to rich virgin soils, unlike our areas which have been under cultivation for centuries together, without adequate manuring. There are also other factors, such as poverty of the cultivators, absentee landlordism and insufficient manuring and the growing of rice in soils not entirely suited for rice cultivation.

In countries like Spain, California, and Italy which record very high yields, rice cultivation is confined to the months of May to September when plenty of sunshine can be had and which is really the ideal season for growing rice. The highest yield in Spain is 5,100 lb. of paddy per acre over an area of 1·2 lakhs of acres. If we take into account, the yields of the Thambraparni valley, acre yields of 5,000 lb. of paddy during the first-crop season are quite common. The fact however remains that the main rice-growing

season in our State is during the North-East monsoon period from October to January. During this period, the days of bright sunshine are very few. The success or failure of the crop raised during this season is entirely dependent on the North-East Monsoon.

Again, our rice crops, whether under rainfed conditions or under river systems are always under the threat of the failure of monsoons and diminished yields thereby. The foregoing remarks should not be taken to mean that it is not possible to increase the yields of rice in our country. It is possible to increase the yields under the existing countries by resorting to the following measures.

Supply of water: Rice is a crop which responds to good irrigation. When there is dearth of water, the yield is reduced by 50% and more. Again, most of the varieties of rice are season-bound. Any delay in sowing or planting in the proper season, due to want of water, reduces the yield considerably. To ensure sowing of the crop in the proper season one must have an assured supply of water at the proper time and that too in plenty. At present large areas of lands under tanks and even the deltaic areas commanded by the perennial rivers are entirely at the mercy of the monsoons. The renovation of the existing tanks that were put up several centuries ago is also an urgent necessity. While dwelling upon the means of conserving and utilising the irrigation water obtained through rain a reference has to be made to the preservation of forests so essential for regulating the rainfall and climatic features of a country. The large-scale destruction of forests which commenced during World War II has not stopped. Our demand for wood has increased with the increase of population and increase of lorries and vehicles utilising charcoal for propulsion. It is high time that an alternative source of fuel as coal is recommended to the public and transport companies, to avoid the huge drain on our forest trees. The destruction of the forests has resulted in the failure of monsoons and more frequent failure of crops. The irrigation reservoirs are there, the tanks are there, but there is no rain to fill up the tanks and reservoirs. So the maintenance and preservation of forests has to proceed side by side with the irrigation schemes so that the catchment areas of reservoirs are not denuded of forest wealth.

The irrigation water thus secured has to be utilised judiciously. The time-honoured practice especially in deltaic areas was to irrigate paddy lands as copiously as possible by allowing water to stand to a depth of 3 to 4 inches at a time. Irrigation experiments conducted at several Research Stations have shown that applying 1 inch of water once in 4 days or 2 inches once in 8 days is enough to give good yields. More than 2 inches of water is wasteful. The economic use of water will also prevent the breeding of mosquito larvae in malarial tracts besides making the surplus water available for bringing more area under paddy cultivation.

Manuring: Next in importance only to irrigation is manuring. A paddy crop removes from an acre of soil 48 lb. of Nitrogen, 23 lb. of Phosphoric acid and 41 lb. of Potash. These are the minimum quantities of manurial ingredients that have to be returned to the soil to prevent soil depletion.

Paddy crop had been found to respond very well to green manuring. With the pressure on land and increase of population, the securing of green leaf for manuring paddy fields has become a serious problem. The necessity therefore arises of growing green manures in the fields themselves in rotation with paddy during the off-season. Thanks to the activities of the Agricultural Department several kinds of green manures as *Sesbania speciosa*, Daincha, Sunhemp, Pillipesara and Kolinji are now available to suit varied conditions. The present area under green manure crops in the Madras State can be put down at $1\frac{1}{4}$ million acres or nearly $\frac{1}{8}$th of the area under rice, As it has been found that the application of green leaf increases the yield of rice at the rate of 1 lb. of grain for every 15 lb. of leaf applied, the increases in yield is certainly remarkable. An increase of at least 300 lb. per acre or 10% increase is easily secured by the application of green leaf at 4 to 5,000 lb. per acre. To secure the best results it is desirable to apply bonemeal or superphosphate at 100 lb. per acre in conjunction with green leaf. It will be admitted that green leaf is one of the cheapest of manures as compared to other manures, especially when grown on the land itself. The present area of $1\frac{1}{4}$ million acres under green manures in the State requires at least to be doubled if not trebled, for adequately manuring the entire area with green leaf.

Coming to other nitrogenous manures such as groundnut cake and ammonium sulphate, it is found that our requirements for manuringthe 11 million acres of rice are about 3 million tons of cake and 5 lakhs of tons of ammonium sulphate. At the present conditions it will take years to produce this quantity of ammonium sulphate within the country, especially when the demand for this fertiliser is very great for crops other than paddy. With regard to groundnut cake, the demand for cattle food also becomes increasingly felt, while the production is only 1/10th of the demand. Added to this, the demand for the industrial uses of the oil within the country is not so much as to prevent the export of raw kernels to countries abroad. Tne possibilities of increasing the production of groundnut cake in the country in the near future are therefore not bright. Hence other alternative sources of manures have to be thought of.

The conversion of all organic wastes into valuable compost has not been as fully utilised in our country as in China and Japan. Town compost and night soil compost have to be utilised to the fullest extent as these are the cheapest forms of manures. A start

has been made in this direction and it is hoped that ryots would fully avail themselves of the opportunity. The village panchayats and municipalities can prepare compost for sale to ryots at reasonable prices.

Use of Good Seeds: The area under rice in Madras is nearly 11 million acres and any small improvement that is effected over this vast acreage is bound to result in considerable increase in total output. In the cultivation of rice, good seed is of very great importance. Selected seed properly preserved and sown gives satisfaction in the seed bed, does not disappoint the farmer as regards the required quantity of seedlings for planting the areas, gives a uniform stand of crop, has even flowering and finally gives a good harvest of 15 to 20% over the unselected variety. The seed has to be sown at the rate of 1 M. M. per cent for wet nurseries and 1½ M. M. per cent for dry nurseries, instead of 3 and 4 times the quantities now used. It has been found that by planting seedlings from thin-sown nurseries alone, the yield can be increased by as much as 5 to 10%. This is due to the better tillering and growth of the sturdy seedlings from a thin-sown nursery.

With regard to the spacing between plants in a transplanted field, this is dependent on several factors as fertility of soil, early or late planting, duration of the variety grown, water supply and so on. Under delayed planted conditions close planting is advised. The number of seedlings per bunch is not much consequence but in the case of wider spacing, a greater number of seedling per bunch shows some advantage over single or two seedlings. It may be stated in general that the optimum spacing in the case of *kar* or short-duration varieties is 4 to 5 inches and 6 to 8 inches in the case of medium or long-duration ones.

As it has been found that short-term varieties of 3 to 4 months duration respond better to manuring than long-term varieties, short-term varieties should be grown wherever possible.

While dealing with the subject of improved seeds mention has to be made of the seed multiplication scheme that is in progress in the State for the spread of paddy strains over the 11 million acres under paddy in the State. The area under the Research Stations being limited, it is not possible to produce seed in sufficient quantities to meet the needs of the entire district or group of districts in which the Station is situated. So there must be an agency, (in the absence of private agencies) to do the multiplication of the seed produced on the Research Station for distribution to the ryots for general cultivation and this is achieved by the seed multiplication scheme.

As already stated, rice cultivation in our State is being carried on in poor types of soil, as well as soils which are alkaline or water-logged and in some tracts under precarious rainfall. Special varieties of paddy have been evolved to withstand these conditions and they are becoming popular. The variety SR. 26–B

is becoming increasingly popular, for alkaline lands. Under the deep water conditions of West Coast, PTB. 15 and PTB 16 are popular, while in the Circars and Kollair Lake MTU. 16 is finding favour with the ryots. As rainfed crops, MTU. 17 and 18 in the Northern Districts and ASD. 4 and ADT. 22 in the Southern Districts have been found to do very well.

The increase in yield sought to be brought about by the means enumerated are likely to be offset by certain pets and diseases. The most important insect pest affecting paddy seed beds, namely the army worm of paddy can be controlled now with the help of the DDT, while the equally important rodent pest namely the rat which is a menace in the deltaic areas can be controlled by poison baits. The important fungus disease, paddy blast, which causes loss to the tune of 10% to 100% in yield is being combated by the release of blast-resistant strains of paddy of which, strain CO. 25 is a remarkable instance.

To sum up, increased production of rice can be brought about by:

1. ensuring adequate irrigation facilities,
2. by proper supply of manures especially green manures and compost,
3. by the use of good seeds as Departmental strains, adopting economic seed rate and proper spacing and
4. use of special varieties of seeds for special conditions as alkalinity, water-logging, drought and immunity to plant diseases.

Modification of Weather for Maximisation of Crop Production

By

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At the present juncture, the Indian Union is faced with the need of maximising food production. With the natural resources available in India, it should be possible to achieve this object, of obtaining the maximum yield from each crop and meeting the food requirements of the population, both human and cattle, in full. The subject of this paper is how to harness the weather to suit the requirements of the farmer.

Weather has to be utilised to the best advantage for the maximisation of crop production. Forestry is generally referred to as the 'Handmaid of Agriculture' as its influence on the climate of a locality is far-reaching. Forests equalise and regulate temperatures. Inside the forests the temperature all through the year will be lower than in the open, and in summer this difference may even be 4°F. The difference between the relative humidity inside and outside forests may be anything upto 12%. Transpiration from forests increases the relative humidity of the locality and brings it nearer the precipitation point. Hence, it is often said that forests create rain. The influence of forests on rains is due to convection currents caused by local heating of the surface air. In addition, forests break the force of high winds and restore moisture to the atmosphere. Data are available to indicate that if the wind penetrates through a dense forest to a distance of 100 feet, it retains only 60 to 80 per cent of its original velocity; if the distance is 200 feet only 50 per cent and for 400 feet only 7 per cent. Reduction of wind velocity means creation of favourable climatic influences, such as reduction of evaporation, lowering of temperature, increasing relative humidity of the air and accumulation of moisture. All these influences will increase the yields of crops, raised under the protective shelter-belts. Most important of all, forests check soil erosion and flooding. They help in the conservation of soil moisture. The water-holding capacity of forest soils is four to eight times that of an open soil in the same locality, due to its high humus content. Further, water enters through the cleavages in the forest soil formed by the roots of trees and gets soaked in the deeper layers of soil, thereby creating environments favourable for the formation of subterranean springs. Later on these springs form streamlets and rivulets which coalesce into a river. Thus, forests are helpful in the formation of perennial streams. This is perhaps the reason for the belief that forests improve the local climatic conditions and also serve as a great adjunct even for dry-farming. Planned afforestation is, therefore, the means of reclaiming lands for agricultural purposes, otherwise threatened by floods and the spread of desert conditions.

So far as Madras State is concerned, it is a good thing that we have got nearly 27% of the land under forests. But the present state of forest upkeep requires more scientific attention. The question of bringing more area under forests does not arise in Madras State. On the other hand, it may be possible to release some lands that are now under forests, for agricultural purposes. In the Ceded Districts, where the occurrence of famine conditions is more common and frequent than in other districts, the main reason may be the vast tree-less nature of the tract, resembling the steppes of Russia. The creation of tree belts in the Ceded Districts may improve the local climatic conditions and prevent soil erosion and encourage retention of soil moisture to the benefit of crops and

eventually prevent the frequent recurrence of famines. Similarly, in the East Coast proper tree belts may minimise the havoc due to the periodical cyclones striking the coast.

Generally by adverse conditions we refer to the failure of the monsoons. It is an oft-repeated statement that, "Agriculture is a gamble with the monsoons." When monsoons fail crop production becomes a failure mainly due to the setting in of drought conditions. Drought affects men, animals and plants, the last perhaps in such a manner that their subsquent revival is not possible. There is also the other side of the picture, namely, heavy floods, resulting in extensive soil erosion and submersion of crops in low lands. For checking both the extremes, forests are useful.

As a practical measure the public should co-operate with the State in setting up a "Co-operative Climatological Service" to give timely warnings of weather conditions by collection of data, careful formulation of forecasts and effective dissemination of the same. The communication system, both private and public, should give high priority to the dissemination of weather warnings issued by this organisation.

Yet, it will be better and safer if the plant breeder evolves strains that will fare normally under extremes of climate. Evolution of drought-resistant strains requires a special technique. Ample facilities are to be provided by the State to assess the drought-resisting ability of various strains of cereals, pulses, oilseeds, cotton and sugarcane. Similarly, strains that will yield normally even under water-logged conditions, created by floods, are to be evolved. Even for the creation of tree belts, it will be advisable to have quick-growing and drought-resisting varieties of trees, whose foliage may also have good fodder value.

By maintaining luxuriant forests in high level catchment areas it is possible to control damage to crops due to floods. Further, by constructing suitable dams and reservoirs, water can be stored when available in plenty for subsquent use during periods of scarcity. The Government of Madras is alive to the value of adequate irrigational facilities for the maximisation of crop production. The Government of Madras is also spending crores of rupees in improving the irrigation facilities including the renovation of the 26,000 tanks in the Madras State. Under an assured irrigational system 90% of the loss due to the vagaries of climate may be avoided. For instance, the Godavari, the Kistna, and the Cauvery delta regions always raise bumper crops of paddy, irrespective of the local monsoon conditions.

Another suggestion to overcome losses due to weather conditions is to have a judicious crop rotation, especially in the dry districts. Fragmentation of holdings must be prevented by suitable

legislation, if necessary, thereby improving the existing facilities to have mechanised agriculture on a co-operative basis. It is a sure method to have the maximum benefit from the prevailing weather conditions. The Ceded Districts may perhaps be the suitable locality for putting this suggestion of introducing mechanisation in agriculture in actual practice.

Though it is not a suggestion to modify weather, it has to be mentioned that the farmers of the different localities must be posted with all details, based on facts, as to what are the different types of adverse weather conditions and how they are likely to affect the crops under cultivation. Steps in this direction are already taken by the Director, Agricultural Meteorology, Poona and 'Crop Weather Calenders' will soon be published in all the regional languages. With these calenders and advance weather information the farmer will certainly be able to minimise the loss due to unfavourable weather conditions.

Soil Conservation and Maximisation of Crop Production

By

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One of the main factors for the present set-back in crop production is soil erosion. Our country is one among the many where soil erosion has become a menace in recent years. As far as our own State is concerned, erosion is certainly doing great havoc though it is insidious, particularly in regions subjected to the effects of monsoonic rains.

The rapid drain on soil fertility caused by erosion would not be so alarming if the lost plant food could be replaced by the application of fertilisers. But the trouble is that erosion not only removes the plant food materials but carries away the soil itself. When the fine top soil is removed, along with it are removed all the humus, the micro-organisms and the fine clay and silt material essential for the proper retention of soil moisture. The physical and chemical nature of the soil is changed, affecting the water holding capacity, the underground drainage, and the underground water supply etc. to the detriment of crop growth.

As far as our State is concerned instances of both wind and water erosion are sufficiently common and quite serious enough, to merit a greater degree of concern and attention than is evident at present. Wind is responsible for blowing away of the fine soil particles from the cultivated fields and indirectly for wave erosion along the shore lines of oceans and lakes. Hence there is an imperative need for the protection of soil. Any scheme for the maximisation of crop production is bound to be defeated if attention is not paid to the conservation of the soil.

Experiments conducted at the Dry Farming Station, Hagari show (vide table I below) that 40% of the Mungari rains and 25% of the total rainfall is lost every year from a gradient of 1 in 80. It carries away 8 to 10 cartloads of rich fertile silt from every acre of the control plot. The experiments at the Agricultural Research Station, Nanjanad show that the loss (vide table No. II) from a gradient of one in ten is 17·74% of the rainfall, and 1·09 tons of soil per acre. The lower amount of run off at Nanjanad is due to the nature of the soil of the experimental plots. The soil is a light brown loam, which is quick to absorb water. The rainfall is more evenly distributed and hence the intensity is less. However when the gradient of of the run-off plots was increased to 1 in 5 th elosses shot up by over 5 times. Thus with the same intensity of rainfail the soil and water losses assume different proportions according to nature of the soil and the slope.

TABLE No. I

Data on Surface Run-off at The Agricultural Research Station, Hagari

Black soil—gradient 1 in 80.

	1938–'39		1939–'40*		1940–'41	
	(a)	(b)	(a)	(b)	(a)	(b)
Number of days when there was run-off	13	10	16	10	11	5
Rain-fall on days when there was run-off	15·66	15·66	8·36	8·36	7·63	7·63
Rain water lost in inches ...	7·52	3·29	2·73	1·34	2·81	1·63
Rain water lost expressed as per cent on rain-fall received ...	48·01	21·01	32·66	16·03	36·50	21·36
Silt lost in tons per acre ...	9·86	3·60	2·69	1·82	1·83	0·98

*Exclusive of 2 days when there was overflow of the cisterns due to heavy rain-fall of 3·82″ on 10—8—1939 and 2·61″ on 25—10—1939.

(a) Control; (b) Scooped.

TABLE No. II

Run-off data at the Agricultural Reseasch Station, Nanjanad

Soil—Brown loam

	1943 Gradient 1 in 10				1944 Gradient 1 in 5			
	A	B	C	D	A	B	C	D
Number of days when there was run-off	66	66	66	66	68	68	68	68
Total rain-fall on days when there was run-off	43·38	43·38	43·38	43·38	45·02	45·02	45·02	45·02
Rain water lost in inches ...	3·21	3·49	1·28	6·95	10·69	14·59	1·04	35·42
Rain water lost expressed as per-centage of rain water received ...	8·46	8·81	2·94	17·74	28·16	35·11	2·45	81·57
Silt washed off in tons per acre ...	0·51	0·61	0·23	1·09	1·81	2·84	0·14	6·09

A—Farm Method; B—Ryots' Method; C—Grass cover; D—Fallow.

Methods of conservation may be broadly classified as (1) mechanical and (2) biological,

Mechanical methods like bunding, scooping, levelling, basin listing are all tried and proved methods of soil conservation. Experiments conducted at Hagari, Sholapur and in the Punjab have proved that bundiug helps to conserve more moisture in the soil. The effect is felt especially in years of poor rainfall. But yet this method is not practised as widely as it ought to be. Bunding at Hagari was done by tke bund-former which forms bunds of about 7" high. These are temporary and are washed away in years of heavy rainfall. The Bombay bunds are of a permanent nature and are 3' high, 2' wide at the bottom and 10" wide at the top. Bunding has helped to increase the yields by 50% in the Punjab, 40% in Bombay and 25% in Hagari and about 45% in the ryots' fields (vide table No. 3 and 4). If such high crop yields could be had by such a simple method as mere bunding, failure to adopt this is simply criminal.

TABLE No. III

Control Vs. Bunding Experiment—Dry Farming Station, Hagari

Field No. 5—Plot area—Gross 0 55 acres. Net 0·33 acres

5th October, 1935 to 14th February, 1936—T. 1 Jonna—replications 4.

	Grain Yield				Straw Yield			
	A	B	C	D	A	B	C	D
Control ...	181·0	170·5	183·0	165·5	384·9	362·4	361·4	421·3
Bunded ...	255·5	257 5	234·3	201·0	531·1	571·5	462 3	426 7
	Significant				Not significant			
	t=5·38, t from tables for n=3 and P— 05=3 182				t = 2 69			

TABLE No. IV

Ryots' field—Bevinahalli--Bellary.

Crop	Control		Bunded		% increase over control	
	Grain lb.	Straw lb.	Grain lb.	Straw lb.	Grain	Straw
Jonna ...	102	602	156	920	51%	52·8%
Cotton—Jonna Kapas	64		91			42·3%
mixture ...	43	106	61	153	42%	44 %

TABLE No. V.

Scooping Trials—Dry Farming Station—Hagari—

Moisture Percentage on dry basis.

26-7-1940—Initial Moisture; 15-10-1940—Moisture at sowing time of cholam.

Depth	(A)		(B)		(C)		Difference in moisture % between the two dates			Rainfall absorbed in inches		
	26-7-40	15-10-40	26-7-40	15-10-40	26-7-40	15-10-40	(A)	(B)	(C)	(A)	(B)	(C)
0- 6"	14·8	25·4	15·5	28·8	15·5	28·8	10·6	13·3	12·7	0·85	1 06	1·02
6-12"	25 8	29 1	24·3	31·5	25 7	30 4	3·3	7·2	4.7	0·26	0 57	0 39
12·24"	22·2	24·3	21·0	30·7	23·0	30 7	2 1	9 7	7 7	0 33	1 55	1·23
24 36"	17·5	19·9	22·5	25·1	24 6	25·8	2·4	2·6	1·2	0·38	0·42	0 19
0·36"	20 0	23 8	21·1	28·6	22·7	28·6	3·8	7·5	5 9	1·82	3 60	2·83

(A) Control; (B) Bunded; (C) Scooped with Danthis and Bunded.

The Goverment has undertaken an exteusive scheme of contour bunding in the Ceded Districts, but the utility of this will be made null and void if the farmers do not realise the need for putting up the smaller 7" bunds in all their independent holdings.

Scooping: This is forming small basins with either the Basin lister or with "Danthis". When the Basin lister moves on the field a depression is caused to a distance of about 3 ft. and then the tyne gets raised so there is an elevation and again a depression. Experiments at Hagari show that the moisture conservation due to scooping with danthis was 2·83" when the non-scooped control plot had conserved only 1·82" (vide table No. V). Resort to this method will go a long way in the maximisation of crop production.

Contour cultivation: On the Hills the crops should as far as possible be sown across the main slopes. Contour embankments and contour cultivation should be practised. The local ryot's method of growing potatoes along the slope with the contour drains may be satisfactory on moderate slopes up to 1 in 10 but for steeper gradients contour cultivation is the only remedy. This not only conserves the soil but in the long run will tend to minimise the manurial bill.

Crop rotation; Crop production can be increased and the soil conserved by adopting a suitable form of rotation. The principle here is to see that the soil is kept protected by some sort of plant cover for as long a period as possible. Cotton, groundnuts, and cholam or potatoes, lupins and rye can very well be included in such a system of crop rotation. In addition to legumes, other plants like rye, buckwheat in the hills, and Setaria, calotropis and Euphorbias can all be used as green manure. Soil erosion can be prevented to a great extent by the application of silt, farmyard manure, composts, green manure etc. to increase the humus content of the soil. Liming heavy clay soils flocculates the clay and makes it settle down quickly and prevents run off.

Terracing: Cutting a steep slope into two bits of flat ground is terracing. The process is rather costly and may be resorted to wherever necessary. This is practised to a great extent in the West Coast where paddy is cultivated but it is not so common on the Nilgiris.

Mulch culture: Spreading any available trash on the soil and producting it from the beating rains is mulch culture. This could be practised with advantage both in the plains as well as on the hills. Any coarse organic material may be used. On the hills about four cartloads per acre of twings leaves, shrubs and trash will be necessary. Experiments are in progress at Nanjanad and the results show that the run-off is minimised and crops come up well.

Gully plugging: Gullies should be controlled as soon as they are observed for they can ruin a field in 15 to 20 years. It is far more easy to control them when they are small than when they form deep ravines. Gullies can be plugged in with stones and cut out earth. Growing of grass, obstructing running water by dams, logs, stones, or concrete will break the force of water and aid the deposition of silt.

The above methods adopted according to the needs of the locality will help to maximise crop production. There is a lot to be done by our farmers themselves by co-operatively performing the necessary operations such as the construction of waste weirs, rivetments, digging of common drains, bunding of nallas, deepening ponds and tanks for holding water and silt, and contour bunding and terracing and tree planting. All these require propaganda and and demonstration.

The gradual denudation of the soil of the country is the real economic drain in India. Unless this denudation is stopped and the fine soil is retained, it is clear that the provision of improved varieties of crops, of irrigation facilities, of improved credit, of better cattle and good implements and manures, will not yield their full results. So let us "Save the soil and save all". We shall "arise, awake, and stop not" till our goal of "Maximisation of Crop Production" is reached.

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Usefulness of Water and Soil Conservation by Bunding Lands in Low Rainfall Areas

By

MIRZA ANSER BAIG

Introduction: Out of the long list of nature's gifts to man none is perhaps so essential to human life as soil. And the top soil is the most vital part of the soil. Lying at an average depth of about 7 or 8 inches over the land, this upper layer of the soil is the principal feeding zone of the plant, which provides food for human or livestock consumption, fibre for clothing and timber for shelter. Soil constitutes the physical basis of our agricultural enterprises. Under many conditions, however it is the most unstable of all major natural resources.

What is Soil Erosion: Water or wind, in moving across the ground surface exerts an abrasive force which picks up soil particles and carries them away in suspension. In a natural, undisturbed environments, the dense cover of vegetation retards this surface transposition of soil. Where the land surface is devoid of protective vegetation as it must be under cultivation, the soil is exposed directly to the abrasive action of the elements. Transposition process of an extremely rapid order is set in motion. Stripped of the protective cover that normally anchors soil to the landscape, this indispensable material is moved a thousand times faster than under natural conditions. This accelerated soil removal is known as "Soil Erosion". Unless steps are taken to check its progress, it becomes the most potent single factor in the deterioration of productive land.

Evil Effects of Soil Erosion. In nature where there is vegetation and much of vegetative debris, there is an equilibrium between the losses in the soil and the recuperation. When man enters the scene this norm is disturbed the losses being more than the recuperation, soil erosion takes place the plant materials in the soil are removed and finally the "crumb" structure of the soil is disturbed. If the balance is to be restored and the productive capacity of the soil maintained, it is imperative to adopt soil conservation methods at a sufficently early stage.

Apart from the damages to or deterioration of cultivated land, soil erosion also causes severe losses to the community by the silting up of natural drianage channels, harbours, irrigation canals, power and water supply reservoirs. There is also a close relationship between the soil erosion and mounting high flood levels of the bigger rivers. The decline and disappearance of many a great civilisation of antiquity are closely connected with the gradual clogging up of the great irrigation and navigation systems on which they depended for their prosperity.

Estimate of Soil and Water Losses by Erosion. The rain is generally spent (1) by surface runoff (2) by evaporation (3) by underground drainage and (4) by plant growth. A sound system of agricultural economy is directed towards maximising the use of rainfall under plant growth. Ordinarily it will be difficult or impossible to prevent losses under evaporation and drainage while it is possible to prevent or reduce surface runoff and thereby increase water availability for growth of the plant. From the results of the experiments conducted at the Sholapur Dry farming Research Station it is seen that about 20% of total rainfall is lost by runoff which erodes away 35 tons of soil per acre per annum in the Bombay-Deccan tract. In other words 1/6" of soil is lost per annum by erosion or 1" of soil is 6 years. In light soil where the depth of soil will not exceed 6" the entire soil will be lost by erosion in about 36 years leaving the hard subsoil bare and unfit for any crop. The

enormity of the losses can be comprehended only when it is realised that geologically it takes 1,000 years for nature to convert rock into soil 1 ft. deep fit for cultivation while it is completely eroded and lost in less than 100 years. The conditions in the Madras-Deccan tract are not much different from those of Bombay-Deccan and the results can be taken to apply with equal force to similar areas in our province also.

It is further known, from agricultural experiments that about 400 lb. of water are required for every 1 lb. of dry matter produced. In order to produce a cholam crop of 500 lb. grain and 600 lb. straw yield about (500 plus 600) x 400 lb. or 200 tons or 2" of water per acre is adequate. Therefore it is possible to produce a good dry crop of cholam only if 2" of rain can be retained in the soil and made available for the crop in the proper season. Allowing surface runoff it should be possible to produce good crops even with a scanty rainfall of 10" to 15" per annum.

This leads us to the problem in the dry tracts of our State, especially Madras-Deccan, of overcoming surface run-off and conserving soil and moisture for increased crop production. Surface run off and soil erosion are taking place every time there is a rain. These are the enemies of dryland cultivation, resulting in frequent famines. Hence combating them should be censidered as a national problem and remedial measures adopted on a wide scale.

Soil Conservation Practices: There are various methods of soil and water conservation which can be broadly classified as (1) cultural (2) vegetative and (3) mechanical methods.

In areas of low rainfall, special cultural methods have been evolved which are known as dry-farming practices. Among vegetative methods are included crop rotation, strip-cropping, ley farming (growing permanent cover grasses) green manuring etc. A sound system of crop husbandry with special emphasis on strip-cropping is considered to be an effective answer to soil erosion problems in slopes up to 1·5%, while the emphasis shifts to ley (grass) farming in slopes exceeding 5%.

Bunding: Mechanical methods are most successful in slopes of 1·5% to 5%. Contour bunding and trenching are the main mechanical treatments, to help in the greatest possible conservation of rainfall and to reduce soil losses by erosion. Contour-bunding is the construction of small bunds across the slope of the land, along the contour lines.

In areas where the rainfall is low, ill-distributed or precarious, this method of bunding the cultivable lands conserves the available moisture in the soil and helps to give an assured crop. The size and

shape of the bund, the distance between the bunds, the provision of waste weirs etc., are matters to be worked out on the spot, taking into consideration the nature of the soil, rainfall data and other factors. The rainfall intensity, duration and frequency coupled with the length and steepness of ground slopes constitute the chief eroding factors while the resisting power is determined largely by the infiltration and absorbing capacity of the soil, its inherent resistance to dislodgement and the nature of vegetation covering the surface. Contour bunding aids the "resisting forces".

However, bunding in itself is not a cure-all for all the ills of soil erosion. Bunding cannot be economically justified on lands (below 1·5% and above 5% slope) that can be adequately protected by proper tillage and other agronomic measures like strip-cropping, rotation, ley-farming etc. But where erodable soils, long slopes and high rain-fall intensities are encountered and where a large percentage of erosion-permitting crops must be used in rotation to provide a profitable farm income, the applicable agronomic control measures may give only partial control and must then be reinforced with bunding before adequate protection from erosion can be assured. Bunding should always be supplemented with the best possible cropping practices because bunding in itself does not improve soil fertility but serves only as a basis for soil improvement and other conservation practices.

Conservation of soil and water, in a national sense, requires the adoption of sound principles and practices. The attainment of this objective includes the wide-spread use of physical measures of land defence and the adjustment of certain economic and special forces tending to encourage exploitation of soil. The responsibility for such a national programme falls upon both the nation and the individual. National responsibility involves the protection of society's interest in a natural resource of vital importance to the whole people. Equally strong, however, is the interest of the individual in the "Good Earth" that he lives upon. National action may be led and aided by the Government but the soil must be conserved ultimately by those who till the land and live by its products. Without a widespread recognition of this responsibility, any governmental programme of soil conservation must be doomed to eventual failure.

Groundnut for the control of soil erosion

By

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Introduction: The soil of a country constitutes its most valuable natural resource, as it feeds the plants which provide all the three basic needs of man, viz, food, clothing and shelter. Soil formation is a very slow process and it takes more than 1000 years to build one inch of top soil, the most vital part of the soil profile. It should be realised that when this top soil is removed, either by wind or by water, 6000 years of nature's work goes to waste. Therefore, it is very necessary to preserve the soil from depletion by erosive agencies.

Soil erosion is receiving world wide attention to-day. Although erosion has been going on for centuries, it is only in recent years that the enormous losses caused by erosion have been recognised. The United States of America was the first to realise the seriousness of the problem and set up soil conservation services. Intensive measures against erosion have also been taken up in the U. S. S R. In most other affected countries, the need for control is recognised though work in this direction does not appear to have made much progress. In India about one half of the agricultural land is suffering from soil erosion. This accounts for the shortage of food for man and fodder for his cattle.

It is now recognised that erosion comes about through a wrong use of land, and the remedy is correct the utilisation, both of land and of water. Soil erosion is of three types viz., (1) sheet erosion, (2) gully erosion and (3) wind erosion. While the first two are caused by water, the third is brought about by wind. In the control of the first two types of soil erosion the measures practised fall into two main divisions viz., (1) the checking of the flow of water by use of vegetation and (2) checking the flow by controlling the slope down which the water flows. Though the loss of soil brought about by wind erosion is not so widely experienced, where it does exist it is very difficult to control. As pointed out by Sir John Russell, for full effectiveness, the plan requires the collaboration of the ecologist, the agriculturist, the forester and the plant breeder; the ecologists to ascertain what plant combinations are most appropriate, the agriculturist and forester to select those of most economic value, and the plant breeder to narrow the gap between the ideal plants and those actually available". In the prevention of all these three types of soil erosion by the use of vegetation the groundnut crop has a special utility. In this paper an attempt has been made to show how the special features of the groundnut crop make it particularly useful for controlling soil erosion.

Sheet and gully erosion: Sheet erosion occurs owing to flooding by heavy rains and water running off the land in sheets. This is responsible for the largest soil losses. Gully erosion is localised, making trenches in the soil which deepen every year, finally leaving flat land into a number of sub-divided plots which are not useful for profitable agriculture (6). These two types of soil erosion exist in varying degrees, depending upon a number of factors. The intensity of their evil effects is not proportionate to the total rainfall received by any place but to its uneven distribution in periodic, concentrated showers. Gorrie expresses the same idea by holding that an important factor in soil erosion is erratic rainfall occurring in a series of torrential storms. In arid regions where the soil is not easily permeable, the loss of surface soil due to sheet erosion by heavy rains is enhanced considerably. The lay and slope of the land, the texture of the soil etc. are other factors which influence the soil losses. Research on soil erosion in America (4, 5) has revealed that the run-off off from cultivated land is less than that from uncultivated land. It has also been shown that under a suitable and well-balanced rotation, for example, corn, wheat and clover, soil loss occurred only during the growing season of the corn, while wheat and clover protected the soil.

It is recognised by all that in agricultural land where crops have to be grown, a judicious crop rotation is one of the important methods of prevention of erosion. Soil is lost only when it is unprotected and exposed to the action of heavy rains for a long period in the year. Thick-growing crops which cover the ground and which are effective in checking erosion must be included in the rotation. This, for prevention of soil erosion in cultivated lands a careful choice of crops to be grown is very important. The groundnut crop has to a very large degree just those characters which make it ideally suited for the prevention of soil erosion. Let us examine this aspect further. When heavy rains occur, sheets of water form in the field, holding within them the fine particles giving the familiar picture of thick, muddy water and they begin to flow down the gradient of the field finally finding a way out at the lowest point. Scouring may occur during this process if the slope is too great and gullies may develop. If the flow of water is impeded as much as possible, soil particles which came up floating in the water would settle down and the excess water alone would find its way out. With the velocity of the flowing water checked there would be no chance for scouring to occur or gullies to form. This condition is fulfilled by the groundnut crop at all stages of its growth. The seed is sown with the first showers of the South-West-monsoon and within the first month after sowing the crop establishes itself on the ground, the vegetative part leaving barely any soil uncovered. When the heavier showers of rain are received the crop would be dense and spreading. This not only helps in receiving the first impact of the water but also aids in increasing its absorption by the soil. By the end of the second month flowering is in full swing and a large number of pegs (gynophores) would have penetrated into the soil forming so many points of support to the soil columns. To use an engineering analogy the whole soil foundation would be 'piled' to secure the stability of soil structure This 'piled' system would last as long as the crop remains, that is to say, until the more intense rains of the North-East monsoon are over. The root system of the groundnut affords further protection to the soil layers. The most well-developed roots spread out

and inter-twine from even within the first inch of the soil in the early stages of the crop itself and form a thick mattress for the first sixteen to eighteen inches of the soil. It is extremely difficult for any soil to scour out from this layer of densely spread roots. In fact in our root studies of the groudnut even a water pressure of ten pounds to the square inch was found insufficient to release the soil particles around the roots.

Though the groundnut crop affords protection by means of its flat vegetative parts to the soil during the South-West monsoon, where the North-East monsoon is prevalent and torrential its value is enhanced in asmuch as the roots, shoot and the pegs would all have developed to their maximum extent. For example in the South and North Arcot districts of this State the showers of the retreating monsoon are the heaviest and the soil should have the maximum cover during this period. From the records of the monthly rainfall maintained at the Agriculture Research Station, Tindivanam (South Arcot District) it was observed that the heaviest rainfall is during the months of October and November. It is in the fitness of things that the South Arcot district is predominantly a groundnut tract so that when the most furious of the rains occur the groundnut crop would be in the full flush of growth, preventing the loss of soil which otherwise would happen.

There are two common varieties of groundnut, the bunch and the spreading, and it is only the latter by its prostrate habit and profuse branching that affords the fullest protection to the soil. This variety is, moreover, longer in duration by nearly a month than the bunch, extending the period of protection by that interval.

Mason Vaugh (2) mentions that the method of utilising vegetation in the control of erosion is confined to the use of cover crops and of strip planting and adds that a cover crop is a crop grown between major crops to cover the soil and prevent erosion when the major crops are not in the field. Any product of it beyond this is incidental, the purpose being erosion control and not yield. Generally in America, but not always, the cover crop is a legume which is used as a green manure. The requirements are that it should be dense, low-growing and that it does not rob the soil of readily available food needed by the next crop. Though such a practice is desirable, the cultivation of crops with the main object of reducing soil erosion may not have much chance of success in India. But if a money crop which has this property also in addition, is to be introduced it is possible that the ryots may adopt it. Happily, in the groundnut we have both these desirable qualities. By growing groundnuts, if not as a pure crop, at least as a mixture with others, the ryots stand to gain financially and the soil losses due to erosion are reduced considerably. Incidentally the productiveness of the land is also increased.

Studies on the relative efficiency of crop plants in checking soil erosion were made at the Dry Farming Research Station, Hagari from 1938–39 to 1941–41. Among the rainfed crops grown in the tract groundnut is the earliest to be sown and the longest to remain in the field. It is sown in June-July and harvested in November-December. Its habit of growth, especially in the spreading variety where the leaflets are all more or less flat on the ground is especially favourable in protecting the soil against erosion. The anti-erosive values of the groundnut when grown as a pure

crop as well as mixture with other crops were recorded at the station. It was found that the spreading variety of groundnut grown as a pure crop and when mixed with tenai afforded greater protection to the soil than the other crops. It had the maximum anti-erosive value, particularly in the top one inch layer of the soil which is most liable for erosion. It was also recorded in another experiment that the loss of water and soil is reduced by as much as 50%, by growing a groundnut crop of the spreading variety.

Wind Erosion: Wind erosion in our State is met with most frequently in the Ceded Districts where rainfall is low and the summers are very hot. The methods practised for its control are few and the only one that comes to mind so far as cultivated lands are concerned is the provision of wind breaks in the form of hedges, trees etc. The method is not entirely satisfactory, because there is no direct protection to the surface soil. Though the groundnut crop may not occupy the land throughout the year, during the period that it does, generally, between July and December when the gusts of wind which accompany the rains are severe, the protection afforded is complete. Very little of the soil can be carried away when a dense mass of vegetation covers the soil, further reinforced by the pegs of the groundnut.

SUMMARY

Different types of soil erosion are described and the factors which cause them are discussed. The utility of the groundnut crop, with its dense, flat, vegetative growth, its extensively developed root system and the numerous 'pegs' formed after the commencement of flowering, is discussed in relation to the prevention of the different types of soil erosion. Though the commercial importance of the groundnut has been well recognised, its utility in reducing soil erosion as compared with the other dryland crops does not appear to have been realised. This article is meant to stress this aspect of the groundnut. From all aspects of view its widespread cultivation in drylands of this State is desirable.

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Women in Maximisation of Crop Production

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This paper deals with the subject of women in relation to crop production and how far they can help to achieve this objective.

Man is the only animal that grows its own food. The rest of them eat their food as and when they find or collect and store food for their future use. The lines of Dorothy Wellesley will bring home the truth how animals are unconcerned about their food :—

"The sheep.....

They stand upon their breakfast,
And lie down upon dinner,

If only we too had,

"Fish growing round our legs,
If we had floors of Marmalade,
And beds of buttered eggs."

We would not have to suffer all the ills of the present day.

Primitive man was just a hunter and food collector. He did not grow his own food. He stumbled upon the discovery only very much later that he could produce from the soil all that he required. It was undoubtedly the women of some primitive tribe who first made the exciting discovery, that plants come up when seeds are scattered upon the earth. When they spat out seeds around their huts, they were surprised to find plants growing up later on. The knowledge of cultivation of plants led to the civilisation of man and from his primitive stage of blissful ignorance, brought him to the present stage of crying for food and yet more food.

So at this juncture, it is but fair that women came forward and showed the world a way out of the woods. Women have, all through the ages, done the job of raising plants. While men went out to hunt and fish, women grew plants around their crude dwellings. Even from the earliest days, women were doing most of the work in producing crops and that too, entirely by hand at first and later on with the aid of crude implements such as the shoulder-blades of buffaloes, deers antlers and pointed sticks of fire-hardened wood.

In Oceania, where animal husbandry is absent, agriculture is practised by women, developed from the age-old habit of gathering seeds and roots. Even to-day, most of the operations in agriculture are being done by women and they cannot be replaced. This truth of women doing all work in the field and at home can be seen even to-day among the Badagas of the Nilgiris. Most of the potato cultivation is done only by women there. The women of Africa, West Indies, Burma and almost in every country devote a good lot of their time and energy in crop production. Are we not employing women on all our farms to transplant, for hoeing and for weeding, for the harvest of crops and many an item of work where manly hands are of no avail?

It is little wonder therefore when the Red Indians say that "When women plant maize the stalks produce 2 or 3 ears, why? Because they know how to produce children." But thank God that twins, triplets and quins are not of such frequent occurrence! It is perhaps the maternal trait of tending children that make women so eminently fitted for tending crops.

It is a fact for legitimate pride that in spite of the disabilities of their physiological make-up, they had been managing the cultivation of crops in the best possible manner throughout the ages. Did not the women of Sparta manage the lands to feed their military husbands who did nothing but fight? It is only when animals were domesticated and used instead of human labour that man entered the field of agriculture. Women, irrespective of their place in life, can come forward and lend a hand to mitigate the present-day problem of food shortage, here and now. Here are some of the suggestions that may be taken up. They are given in the spirit that a penny saved is a penny earned.

Women can, where ever there is scope, raise a small kitchen garden round their dwellings and grow pot herbs, root crops and vegetables. They need not depend on their menfolk to do this job. The bread winner often winds a long way to office, spends many hours there and returns home too weary to do any work. If women spend a few happy and healthy hours every day in their garden they could save a lot and save the bother of buying stale things from the market or from street hawkers. If they grow more than they require they may freely exchange them with their neighbours or sell them to others.

Women can look after a cow or two if they find place in their houses, to meet all their milk requirments. A cup of good milk is worth four you buy from the rider of the steed of steel. Eggs, a lot of them, you can have and fresh too, if you keep a small flock of fowls. We believe that an egg a day will keep an ounce of rice

away. What is meant is that we can manage with the rice that we get as rations if we take a variety of dishes. This suggestion is not meant to affect the vegetarians unless they wish to change the classification of eggs.

Bee-keeping is yet another way of providing sweet food for young and old with little trouble.

Women can do a lot reduce the demand for food if they reduce waste. The age-old adage "Waste not want not" was never truer than it is to-day. They can achieve this by making dainty dishes and adhering to austerity menus. Entertainment on a lavish scale leaves a lot of waste in its wake. Women can render some service to the nation at large at the present moment if only they make up their minds to observe a few simple things while processing food for the table. Polishing rice is almost a craze now-a-days; while it satisfies the desire for glamour when rice looks like jasmine flower at the table, it is devoid of all its goodness. Why not women do all the pounding of rice as of old in their own homes? They will get all the bran too and the much-needed vitamin B.

If more of millets and pulses are included in preparations, wherever possible, there is no need to be depressed about the reduction of rations now and then. More of roots and tubers can be included in the daily menu. Even an ounce of groundnut in the daily diet will make it richer.

Women can help a lot in saving foodstuffs that would otherwise go to waste by sun-drying or "dehydrating", as it is called by the scientists. Drying of bananas, mangoes, brinjals, fish, meat etc., was common in our country for ages. The idea behind this primitive practice has been to provide some victuals against rainy days. Canning of fruits and vegetables can be done at home and every housewife can do it with a little practice. With some care and ingenuity, every housewife can do many other useful things that will be too lengthy to describe here. If she only bears in mind that if she makes less demands on the meagre stock of the Nation's food she would be serving her country well. It is now her duty to render all the help she can, directly or indirectly, to tide over the present crisis.